THE

ELECTRICAL REVIEW.

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THE

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THE JUBILEE OF SUBMARINE TELEGRAPHY.

IN the course of a gossipy article in the *Revue Pratique de l'Electricité* a short while back, M. Wilfred de Fonvielle offers some interesting reflections and speculations *à propos* of the projected celebration of the Submarine Cables Jubilee in 1901. Apparently he has somewhat confused the two objects finally decided upon by the committee, viz., the present Pender memorial and the projected jubilee celebration of five years hence.

He also rather puts the cart before the horse, for he speaks of the "Memorial to Submarine Telegraphy" (*monument de la télégraphie sous-marine*), "consecrated to the memory of all," &c., being "inaugurated" in 1901.

For these slight symptoms of muddlement, English readers will, no doubt, readily forgive him; for, indeed, the real objects of the original proposal which the committee had to deal with were far from self-evident, even to the great B. P. itself, much less to any foreign observer. But by that peculiarity which is so conspicuous a trait with French writers, our amiable Parisian *confrère* persists in speaking of the late lamented cable king, "Sir *Georges* Pender," and of another still more eminent man as "Lord Kelern"? Such is fame! He manages, however, to pull through with the other names referred to—Sir Charles Bright and Mr. Cyrus Field.

It would, perhaps, be somewhat of an exaggeration to proclaim, with M. de Fonvielle, that the remarkable developments of trade, industry, colonisation, and geographical knowledge effected during the last few decades, are due *exclusively* to submarine telegraphy. We may, however, affirm with confidence that, but for the electrical nerves with which it has been furnished during these latter days, the recent rate of the world's progress in the above respects could never have been as great.

Speaking as a patriot, M. Fonvielle is quite in his own element when he refers to the promising development of this industry which has lately taken place in France. We islanders are no longer to be allowed the monopoly of the world's cable enterprises, and the 1901 jubilee will no doubt be honoured by "duly accredited" delegates from the neighbouring Republic.

On the historical side, M. de Fonvielle retails the good old story of the Boulogne fisherman, who cut off a piece of the first 1850 Dover-Calais line under the impression that he had hooked a specimen of some rare seaweed. He takes this and its sequel—the abandonment of the original French Company—as an instance of small causes producing mighty consequences. Possibly our readers will not be prepared to agree with the particular inference which he draws—namely, that, but for that little mishap, France would have preceded England as the home of cable industry and enterprise!

Such a notion may go down among his own compatriots—the less well-informed, that is—but will hardly do so on this

side of the Channel; it's altogether too "thin!" Whether he has more solid grounds for his suggestion that the croakings of M. Babinet, French Academician and publicist, anent the hopelessness of ocean telegraphy, were taken so very seriously at the time, that they nearly "choked off" the promoters of the first Atlantic cable, is a point which we will leave others to decide. But apart from questions of logical and historical accuracy, both incidents are amusing in the light of subsequent events.

The present generation of telegraph men may still glean both entertainment and instruction from these and other "simple annals" of the past—well-nigh buried in oblivion, but unearthed and presented to us now and then in pleasant garb by fluent, popular writers, like M. de Fonvielle.

He is probably right in his expectation that, by the time of the 1901 jubilee, the Pacific cable will have become an accomplished fact, thus completing the "girdle" round the oceanic globe. Only a few weeks ago such a prediction would have appeared over sanguine, but the world moves. But between four and five years would be sharp work for the completion of a brand new, all-round-the-world system. His further idea that, by this time (1901), ocean telephony may also have been realised, sounds less probable; but we should be presumptuous to sneer at it. Anyhow, we shall see what we *shall* see.

By the *réseau supplémentaire* with which he hopes (and seems almost to anticipate) the existing cable systems will be re-inforced, he means, no doubt, a *French réseau.*

With these reflections we must leave M. de Fonvielle for the present, only hoping that the grand aspirations which he utters for the telegraphic progress of his own country and the whole world may not tarry too long ere they are realised.

THE FORCE OF ONE POUND.

In the pages of *Nature* the professors have been falling out over the accursed poundal, and honest men, that is to say engineers, seem likely to get back the good old solid pound. We all know Prof. Lodge and his worship at the shrine of definition and terminology. He is one of the priest of the cult of new lamps for old—we mean new terms for old. He would not call a spade a spade, but would, like the Lancashire collier, call it a ——— shovel. Prof. Perry is of a different mind. He would not mind digging with a shovel or putting on coal with a spade, and failing a better tool, would go gardening with a bricklayer's trowel. He is a veritable publican to Prof. Lodge's pharisee. Indeed, Prof. Lodge seems to think no unit terms can be of any good unless they require a terrible lot of comprehension, and we fear the poundal has nipped many a plain understanding in the bud. We are not very clear ourselves as to why there is so much discontent with the pound as a unit. To speak of the pound is now voted coarse by academical men; but probably they don't know why. As Prof. Perry says, we might use a spring balance as a fixed unit, for we know that the pound weight in London would pull the balance differently at another latitude. It really seems a pity that the earth's diameter was ever found to vary as between pole and equator, or that the earth revolves on its axis and disturbs our units. Pity it was ever found out. Rankine used the pound, and so did Joule; to Prof. Perry these men represent Moses and the Prophets in engineering matters, and to this we may say "Amen." What did for Rankine and Joule may serve us well enough, and we cannot confess to fellowship in the poundal cult. To begin with, its very name is a misnomer, for it suggests the pound, which it is not, and it is a nuisance anyhow. Now Prof. Lodge is purely academical. He would be of that school to which belonged the man of science of the high and dry type, who having found out something new, was ultra pleased with his discovery, because nobody could possibly get any practical commercial good out of it, much as though he had invented a machine to convert platinum into silver.

Not so Prof. Perry, who seems to have a clearer understanding than his antagonist as to the side on which butter is spread. He is full to overflowing of admiration of the common-sense engineer, and does not grudge him his tenacious grip of the "curious and ill-understood deportment" of bodies which engineers call *weight*, and so foolishly set up as a fundamental property of matter. To the engineer, weight is the chief property of matter for good or evil, and conjoined with that most important item strength, be it tensile or compressive, establishes the question of structural stability, while it is the engineer's justification for all he does. To call the pound the colloquial unit of the shire in which one happens to live, as does Dr. Lodge, is evidence of very narrow views. We presume that even Dr. Lodge still retains sufficient of old-fashioned patriotism to be glad he was born an Englishman. He might have been born a slave to the German Emperor like 50 million poor creatures across the North Sea. Yet patriotism is out of date as much as the pound. All the same, it is a good thing; and so is the pound, or any definite unit of weight, but it is useful, and so is of no use to the professor. Prof. Perry states that certain of the academicians would bar a table of logarithms from a student who cannot calculate them. This sort of thing might be good enough for Methusaleh, but carried to its logical sequence it would compel a joiner to forge his own chisels, when he would be first a smith, and obviously bound to make his own steel. If we are to go back on these lines, we may all start iron making at 10 years with a sheepskin bellows and a catalan forge. Strict mathematicians forbid any liberties, and we have been severely taken to task for using tables of sines, &c., for getting out lengths of sides. We cannot state the reason for the objection, as we did not understand it at the time. What we did understand was that we found a result in a machine problem in half the time taken by our critical genius.

Mathematicians, and many professors, will not see that life is short, and that we must be content to use the tools we can procure, and not necessarily make for ourselves.

Resistance Coils for Telephonic Experiments.

The misleading results which arise in telephonic experiments when using an "artificial line," from the static induction between the turns of wire on the resistance bobbins have been clearly pointed out by Lord Rayleigh. M. Chaperon has proposed to partially get rid, or rather neutralise, this static effect by winding the bobbins with a single wire, the layers being wound alternately in opposite directions, a very ancient method of winding; by this arrangement the successive layers neutralise their dynamic inductive action as in the ordinary method of double winding, whilst the neighbouring points having between them a difference of potential much less than the number of turns is great, the apparent capacity is, it is stated, reduced. How far this arrangement is effective we are unable to state. That the inductive capacity of resistance bobbins is by no means inconsiderable, may be judged from the fact that a bobbin double wound with two platinoid wires, each having a resistance of 5,000 ohms, the dimension of the bobbin being but 1¼ inches diameter and ½ inch long, has a static capacity between the two wires of nearly ·015 microfarads.

THE PROGRESS OF ELECTRICAL ENGINEERING IN GERMANY.

FROM an interesting article in the *Electro-Techniker*, by R. Lüders, it appears that in Germany within the last twelve months, the supply of current to towns for lighting has increased about 20 per cent. as indicated by the number of lamps connected on to the central stations; a percentage increase which means about 150,000 lamps. The combination of lighting with electric traction continues to prove very advantageous, and such installations have been pretty extensively carried out. The important reduction in price, that follows from longer hours of consumption, is illustrated by the tariff of an Upper Silesian installation, where the rate is ·6 pence per hour up to 400 hours, and ·24 pence per hour thereafter. The driving of machine tools by the electric current has been considerably extended; the electric transmission of power on warships has also been very successful.

In the field of railway working a considerable advance has to be noted; the electric current has been used for shifting points at Berlin-Westend and Untertrückheim stations. According to the reports of the principal firms, the alternate current, and especially the Drehstrom, is fast gaining ground on the continuous current. The Drehstrom has been employed in an electric railway at Lugano.

At Dresden, five street railway lines are driven with an expenditure of 1,500 H P.; the Hanover light railways consume 1,500 H.P. developed in two power stations; and the extended Buda Pesth street railway consumes 650 H.P. The total length of completed electric railways in Germany is 523 miles, while 512 miles are in course of construction.

On the first of October last year there were in Germany (excluding Bavaria and Würtemberg) 8,554 heavy current installations at work, 8,160 of which were devoted to lighting purposes, and supplied 1,852,000 glow lamps, and 79,000 arc lamps; 111 installations were used for electrolytic processes, and 618 for power transmission.

In the telegraph engineer's department of the Imperial Post Office several scientific investigations have been carried out; for instance, experiments on the spread of strong currents through the ground, and their availability for telegraphy without wires; investigations to determine the best form and material for telegraph lightning conductors and their earth connections; and investigations to discover the best means of protecting telephone, &c., lines from disturbances from leakage in heavy current circuits. In telegraphs and telephones a notable advance is to be noted; at the date cited, the network of conductors in the German Empire (including Bavaria and Würtemberg) consisted of about 90,600 miles of line and 130,000 miles of conductor, against 87,500 miles of line and 98,500 miles conductor in the previous year. There are 21,271 telegraph offices, of which 8,591 are provided with telephones. Alarm signals can now be sent from 9,796 stations, whereas in the previous year the number of stations was only 8,441.

Special activity has been exhibited in the building of trunk lines for connecting the telephone installations of different towns. During last year 7,200 miles of conductor have been used for this purpose. There are at present in existence 484 city telephone exchanges and 125,810 telephones, for which, on an average, 1,720,000 connections are made per day. Berlin alone has 82,865 speaking places for which the daily average number of connections is 450,000, a record which is as yet unsurpassed. The longest telephone line in Germany, between Berlin and Memel, is 600 miles in length. This, however, is by no means the limit, with the present apparatus; successful experiments have shown that distinct speech may be transmitted over three times that distance.

SPEED REGULATION OF DIRECT CURRENT MOTORS.

THE usual method of regulating the speed of a direct current motor is by placing a variable resistance in series with its armature, and varying the torque on its armature by altering the current passing through it. This method is obviously open to objections from an economical point of view.

In a very suggestive paper read by Mr. H. Ward Leonard on November 18th, 1896, before the American Institute of Electrical Engineers, an alternative method is recommended in which the control is effected by varying the potential difference between the motor terminals, not by means of any regulating coils in the motor circuit, but by placing a rheostat in series with the field coils of the dynamo which drives it.

The suggested arrangement is diagrammatically represented in fig. 1, which is taken from Mr. Leonard's paper.

S is an engine running at constant speed; G is the dynamo which drives the motor M; E is a circuit of constant E.M.F. from which the exciting currents of both generator and motor are derived.

C is a regulating rheostat placed in series with the field windings of the generator G.

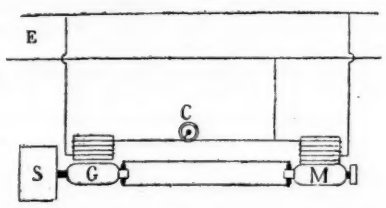


FIG. 1.

It is to be noticed that the excitation of the motor is constant—neglecting armature reaction—and therefore the torque on its armature is proportional to the current which flows through it. Since the generator is driven at a constant speed the E.M.F., and consequently the current, which it develops is proportional to the degree of magnetisation of its field magnets.

By means of the rheostat, C, therefore, the current generated by the dynamo can be varied at pleasure; that is, the controller, C, supplies the means of varying the current through the armature of the motor, M, and consequently of varying its speed.

Suppose that the E.M.F. of the generator, when C is short circuited, is 250 volts, and that its full working current is 100 amperes. Also let the resistance of the motor armature be 0·05 ohms, and its speed under full torque 500 revolutions per minute; and let the current demanded by the frictional torque of the motor be 10 amperes.

If the motor is kept under full load while the generator E.M.F. is varied by means of the controller, C, we arrive by simple calculations at the following results:—

E.M.F. of generator.	Corresponding speed of motor in revolutions per minute.
250	500
125	245
25	41

It is thus seen that the speed of the motor is approximately proportional to E.M.F. of the generator.

A more important feature is, however, the constancy of the speed of the motor under a variable load.

If when running under full load at 41 revolutions per minute the load is suddenly thrown entirely off, so that it is running against frictional torque only, its speed will become 50 revolutions per minute; that is, with a variation from full load to no load, the change in the speed is only 9 revolutions per minute. The variations of the E.M.F. of the generator are accompanied by very little waste of energy in the controller, C, and the E.M.F. is varied so gradually that there is no danger of damaging the insulation by excessive instantaneous differences of potential or by overheating the conductors of its armature.

If corresponding calculations are made for the same motor

under full load, governed by a rheostat placed in series with its armature, we arrive at the following results :—

Potential difference between terminals of motor in volts.	Speed of motor in revolutions per minute.
250	500
125	250
25	50

To change the speed from 500 revolutions per minute to 50, 220·5 volts must be absorbed by the regulating rheostat, that is, since the full load current is 100 amperes, the watts wasted in the resistance are 22,050, whereas only 2,450 watts are used to drive the motor.

If the motor is running under full load at 50 revolutions per minute, the load is suddenly thrown off, the speed suddenly rises to 456 revolutions per minute, or there is a sudden change of 406 revolutions per minute; whereas it was shown that a change of 9 revolutions only per minute accompanied the same variation of load when the control was a rheostat in the field of the generator.

There is, in fact, no control over the speed under variation of load in the case of regulation by a rheostat in the armature circuit. In this case a variation of 12 per cent. overload when running at 41 revolutions per minute, will cause the motor to stop, whereas with the other system of control there will only be a drop of speed of 1 revolution per minute.

Furthermore, if the control is a resistance in the motor armature, there is considerable danger of excessive heating of the armature, for, if when the motor is running at a slow speed the controlling resistance is switched out, the potential difference between the terminals of the motor increases far more rapidly than the speed, and the excessive current may destroy the armature before the counter E.M.F. has increased to a sufficient extent.

Let us now critically examine this "E.M.F. control," as the author terms his method of placing the rheostat in the field of the generator, in contradistinction to the "ohmic control," or that in which the resistance is in series with the motor armature.

There is no doubt whatever that, as far as the performance of the motor is concerned, the E.M.F. control is vastly superior to the ohmic control. In the latter case the load must be tolerably constant or else the motor will run in a succession of jerks, to get rid of which an attendant will always have to be at the regulating switch. The attendant must also be skilled in the manipulation of such switches to avoid the risk of burning out the armature. Also if it is required to run the motor below normal speed, and at full

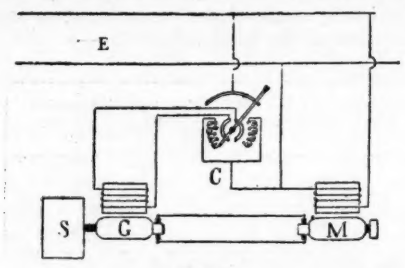


Fig. 2.

load, the same power is required as for full speed. In the instance quoted above we saw that when running at one-tenth of its normal speed about nine-tenths of the power required is wasted in the regulating rheostat, and the engine is called upon to provide ten times the power necessary to drive the motor. This is a very serious item from a commercial point of view and a feasible remedy would be hailed with delight.

Let us enquire to what extent the proposed remedy is feasible.

The point to notice is that the regulation takes place through the field of the generator. Every time the regulating switch is moved the E.M.F. of the generator is altered. The generator, therefore, cannot be used for two purposes at the same time, and the device, in its simplicity, is useless if the source of power is the generators at a central station. The same objection does not, however, always apply for a manufactory where the machinery is driven by motors and where the manufactory possess a generating plant of its own, and has a quantity of machinery which has to be worked simultaneously at the same rate. To such a place we can recommend the system of E.M.F. control.

By adopting the E.M.F. control where possible, the economy of working is enormously increased, the safety of the whole plant is insured, the necessity of a constant, or of a skilled, attendant is obviated, and the steadiness of working of the motors under a variable load is rendered almost perfect.

For example, if a motor is employed to drive a main shaft from which several machines are driven by countershafts, the sudden stoppage of one or more pieces of machinery will not materially affect the rate of working of the other machines. And, further, the direction of the motor can be reversed by means of a reversing switch, as shown in fig. 2.

Mr. Leonard's paper is of a theoretical nature, and we should like to see the results confirmed by experiments. It seems to us probable that there may be serious sparking at the commutator of the generator when the field is weakened beyond a certain extent.

As far as we can judge, the method of E.M.F. control for the regulation seems to be worthy of very serious consideration for private installations where much motive power is required, but we fail to see how it can possibly be used where the source of power is a supply company's mains.

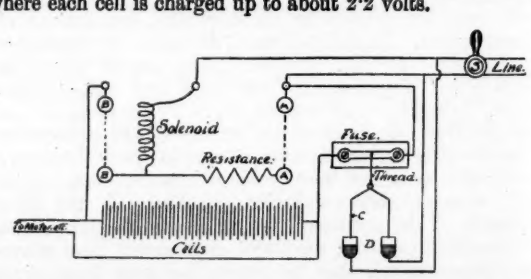
AUTOMATIC SWITCH FOR CHARGING ACCUMULATORS FROM AN ARC CIRCUIT.*

By EDGAR KIDWELL.

Since the first article under the above caption appeared in the November 11th issue of this journal, the writer has had an opportunity to subject the instrument to severer tests than were possible at first. These tests developed some defects and suggested improvements, which will now be described.

With only a few cells in circuit the design in figs. 3 and 4 of the original article gives good results. But since the resistance is on the opposite side of the solenoid from that in the design given in figs. 1 and 2, it follows that the potential difference causing the spark when the cells are thrown in, is that of the whole battery plus that necessary to drive the current through the resistance. In consequence, if the cells exceed about a dozen in number, the sparking is excessive and the instrument cannot be considered satisfactory.

This defect is entirely obviated in the first design, here reproduced with certain additions. It is only necessary to make the resistance such that the fall of potential between its ends, when the arc current is passing through it, equals the potential difference between the terminals of the battery, where each cell is charged up to about 2·2 volts.



The writer now has 60 cells in series attached to an instrument adjusted in this manner, and the spark at A A, when switching in the cells, is practically nil. When the number of cells is liable to vary from time to time, as in a laboratory, a variable resistance must be used for the best results. Graphite resistances have not been satisfactory to the writer; hence he now uses metallic resistances entirely. The switch should, of course, be of the snap type, since a short circuiting switch, if thrown while the cells are charging, will short circuit the battery, since the automatic switch cannot

* *Electrical Engineer*, New York.

act quickly enough to prevent the discharge current passing through the solenoid, thereby holding the beam down and keeping path B B closed.

But there is always a possibilily that an improper switch might be put in through mistake, or that the line wires might get crossed, or grounded, &c., and since one experience of this kind might ruin the cells, the following safety device has been used by the writer: A fuse, of capacity 50 per cent. in excess of the arc current, is put into the charging circuit, as shown. Should the cells be short-circuited by crossed wires or the switch S, &c., the automatic switch cannot act quickly enough to open B B, but the fuse will blow out, and no harm can be done. But should the line current be turned on again before a new fuse is put in the automatic switch will act as usual, and since the charging circuit is broken, an arc will be established at A A. To prevent this, two deep mercury cups are provided at D, and above them is a horseshoe shaped bridge piece, C, suspended from the fuse by a thread. When the fuse blows, the bridge falls, and the automatic switch, &c., is cut out, while the line circuit remains intact.

THE ECONOMY OF THE MODERN ENGINE ROOM.

WRITING to the *Engineering Magazine*, Mr. E. J. Armstrong considers that guarantees for engine performances are made very loosely by builders of engines, simply because they know so few plants are tested and they take the risk. The trouble and expense of machine tests are considerable, and if the engine is satisfactory in other respects, the purchaser will not even allow the consumption of an excess of fuel to hinder full payment, even though such excess be sufficient to pay interest on the cost of the engine several times over. So long as guarantees are asked by purchasers, their non-fulfilment is hardly fair to engine builders who have asked prices to cover a really good engine and have lost the order to some man who has taken the risk of guaranteeing a poor one. The author recommends that the builder be made to test the engines he produces, and show to his customer that they are what they profess to be in economy.

The best shops are now equipped for the purpose, and contain surface condensers and weigh tanks, with Prony or other dynamometers. It ought to be comparatively an easy matter for an inspector to satisfy himself that he is getting all the steam used by the engine at the condenser discharge, and to check the substantial accuracy of the weight by measurement, and also to check the dynamometer with fair approximation. Then with a thermometer to tell him whether the steam supplied be superheated (he need not trouble himself as to any wetness of the steam if the builder does not) or not, and his own private pressure gauge, he ought to be able to get a fairly close approximation to the truth. The neatest thing in the way of indicators for testing the power exerted by an engine over any length of time is the Ashton continuous indicator. Why these instruments are not more used is surprising.

Speaking of engine friction, our author thinks that in well designed engines of high speed type up to 200 H.P. the internal friction may be as low as $4\frac{1}{2}$ per cent. This is very rare, but there should be no toleration of more than twice this figure. In such engines the no load friction will be the same as that at two-thirds the ultimate capacity of the engine, *i.e.*, about the rated power, being a little higher at intermediate loads or at loads greater than rated capacity. In slow speed engines friction is least when running light, and as it increases all the way up to maximum load it is incorrect to take the friction from the friction card.

In electrical working the general efficiency of the whole establishment may be roughly checked between the coal heap and the recording wattmeter, and in all works our author would have checks on the working of the plant. In all large works he would *weigh* both coal and feed, and would have it recorded when the fireman raised or lowered the ratio of coal feed. Regular records of this description are most valuable. Where there is much shafting they would indicate shafts out of line, warm journals, and so on. Thus, if there be self-oiling boxes lasting six months, he thinks they would be filled at less intervals if careful records were taken just before and just after cleaning and refilling. Perhaps such habits would lead very quickly to electrical systems of transmission in place of shafting. We have, ourselves, seen an Ashton power meter call attention to a single hot neck in a mill of several hundred horse-power by the increased rapidity with which its needle began to revolve round its index face. It is the easiest thing in the world to let a steam plant fall below its best efficiency. If this occurs in the boiler house, and the fireman has a reasonable intelligence, he soon finds out how to evaporate to best advantage and learns the best way of firing under all circumstances. Moreover, he will discover his own value, and can very well be kept from making unreasonable demands by facing him up with his records. At the same time, he will be quick to want his merits recognised, and it is as well to do this, for a tenth of what he can sometimes save may often be a consideration with him.

ELECTROLYTIC CONDENSERS.*

BY ALBERT G. DAVIS.

IT has been known for some time that the electrolytic cell was a substitute for the condenser, and could be used to advance the phase of an alternating current, and the patent was held by the Stanley Electric Manufacturing Company up to last week. But on November 17th there issued to Hutin and Leblanc, the well-known French inventors, a patent which covers the idea quite broadly. The first claim is: "In combination, with an electric circuit possessing self-induction, charged with alternating currents, of an electrolytic polarisation-battery having a sufficient number of cells in series to neutralise by polarisation the E.M.F. of the self-induction of the circuit, substantially as described."

In the Hutin and Leblanc Belgian patent of January 9th, 1891, the inventors show their well-known alternating motor in which the two-phase currents are obtained from single phase by the use of a condenser, and state that a polarisation or electrolytic cell will serve as a substitute for a condenser in any of the forms which they describe. Relying on that disclosure, they filed the application on which patent has just issued and won an interference with the above-named company. But in the testimony there were brought out references which caused the office to again reject the case after the interference was decided. It appeared that Mascart and Joubert, in their work on Electricity, had shown that the counter E.M.F. of a cell when charged with a low current is proportional to the total charge. This is also true of the condenser. And the work also gives equations connecting the frequency, self-induction and size of cell for the condition of perfect neutralisation of self-induction. This, in connection with an old article of Maxwell on the use of a condenser in circuits with self-induction, was construed to anticipate the claims.

But a series of arguments were filed, and the case at length went to issue, so that the ownership of this particular property is changed, after a hotly-contested fight. The invention is not of the great importance which it was at one time supposed to be. The analogy to the condenser fails in one important respect. The conduction through the liquid is a positive one in the electrolytic cell, and in the condenser is merely a dielectric displacement current. In the latter case there is no C^2 R loss; in the former it is a very serious factor. This fact has prevented the use of the electrolytic cell on a large scale in commercial work, though there is no known reason why it should not be useful in starting single-phase motors, where it need only be connected in while the machine is getting up to speed, as of course either the synchronous or the induction motor will run with a single-phase inducing member after it once attains speed.

Owing to the long life of the Belgian patent, the American case does not expire until January 9th, 1911.

* New York *Electrical World*.

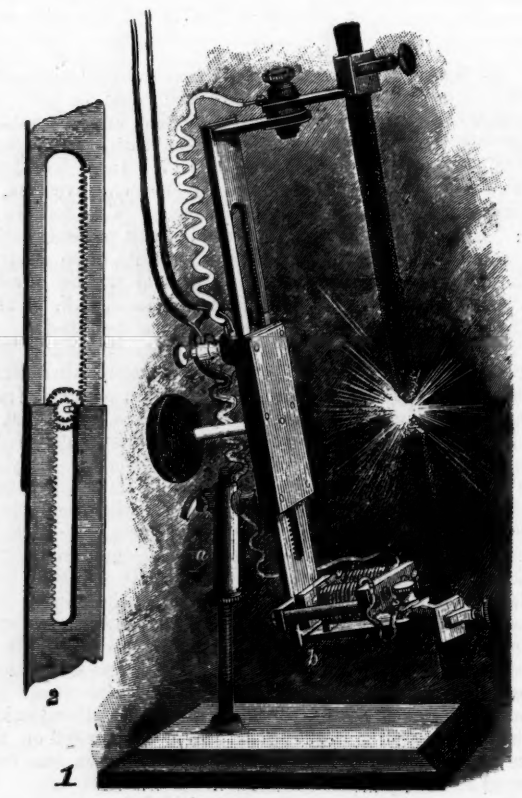
HAND FEED ELECTRIC LAMP FOR LANTERNS.*

BY GEORGE M. HOPKINS.

WHILE a good automatic lamp is undoubtedly preferable to a hand lamp for uses necessitating the absence of the operator from the vicinity of the lamp, it is certain that an ordinary hand lamp is not to be despised, and when the hand feed is supplemented with a magnetic device for striking the arc, the difference between the two types of lamps referred to is not to the disadvantage of the hand lamp when the latter is used in a lantern, or for some other purpose which permits the operator to remain near the lamp, so that he may adjust it at intervals of about four or five minutes.

The lamp shown in the illustration has been used for an entire evening without a flicker. The upper, or positive carbon, is cored, and the lower, or negative, is solid, hard Carré carbon.

On the threaded rod extending upward from the base plate is placed the sleeve, *a*, which is connected with the slide holder so as to have a slight inclination, as is usual in lamps for lanterns, in order to expose more of the face of the crater of the upper carbon. The slide holder contains



two slotted slides; the one holding the upper carbon being 7½ inches long, the one holding the lower carbon being 5⅛ inches long, each being 1¼ inches wide. To the lower end of the lower slide at *b* is pivoted an arm extending outwardly and supporting the lower carbon-holding socket. To the arm near the joint thereof is secured an upwardly extending stud carrying an armature. An electro-magnet having an elongated yoke is supported in front of the armature by brass studs attached to a brass cross arm fixed to the lower slide. A curved brass spring fastened to the armature bears on the poles of the magnet and serves the double purpose of throwing the armature back and the carbon upwardly when the armature is released, and of preventing the armature from sticking to the magnet.

The upper carbon-holding slide is provided with a fixed arm extending outwardly and supporting an insulated carbon-holding socket. These sockets are connected with their respective arms by bolts, which are surrounded with soapstone insulators provided with flanges which separate the sockets and the arms. The heads of the bolts are insulated by means of mica washers. The holes through which the bolts extend are made oblong to permit of adjusting the carbons in a way to secure the best results, that is, by arranging the point of the lower carbon so that it will be slightly in front of the axial line of the upper carbon when the lamp is in operation.

In the slots of the carbon-holding slides are secured racks, which engage pinions on the spindle journaled in the slide holder (fig. 2). The pinion for the lower carbon slide has half as many teeth as there are in the pinion for the upper slide, so that when the spindle is turned by the rubber hand wheel the carbons are moved in proportion to their relative consumption.

To an insulating strip attached to the back of the slide holder are secured two binding posts for receiving the wires connecting the lamp with the current supply. One binding post is connected with one terminal of the magnet, and the other terminal of the magnet is connected with the lower carbon socket. The other binding post is connected with the upper carbon socket.

The magnet is wound with coarse wire (No. 16 or No. 14), and the armature is adjusted to pull down the lower carbon about ⅛th of an inch. The carbon-holding sockets are formed of square brass tubing, with a screw at one angle which forces the carbon toward the opposite angle, and thus centres and aligns the carbons.

The Edison direct current is suited to this lamp when about 15 ohms resistance is introduced in series with the lamp. A suitable range of current is 8 to 12 amperes.

The great advantage of the arc striking device is that, after the carbons touch, the arc is instantly formed of the right length, thus saving the trouble of any fine adjustment by hand, and avoiding the possibility of any long continuance of a heavy current on the circuit. A very slight turn of the adjusting spindle, once in about four minutes, insures perfect steadiness. It is well to form a habit of thus regulating the arc after each change of slides. The illustrations are approximately one-third size.

* *Scientific American.*

A MECHANICAL THEORY OF ELECTRICITY AND CHEMICAL ACTION.

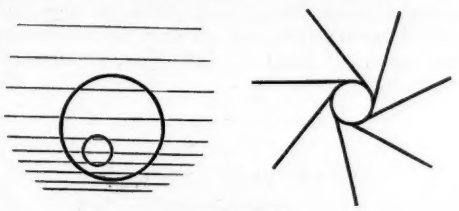
BY ARTHUR WHITWELL, M.A., A.R.C.Sc.I.

IN his book, "Modern Views of Electricity," Prof. Lodge has attempted to explain various magnetic and electro-magnetic phenomena by the aid of the idea of rotating molecules; he pictures a conductor or the ether as being full of gear wheels, and has familiarised us with the notion that electrical and magnetic phenomena have something to do with a rotation of particles in a conductor or in the ether. Again, Prof. Dolbear, in a very suggestive lecture recently delivered at the Franklin Institute, has pointed out that electricity, like heat, ought to be regarded as a molecular phenomenon, that electricity cannot exist apart from matter any more than heat, that there is no essential difference between electro-magnetic radiation and heat radiation, both being movements of the ether, and finally, that as heat phenomena are due to molecular vibration, so probably are electrical phenomena due to molecular rotation.

The object of this article is to develop this idea of molecular rotation, and to suggest by its aid a mechanical picture of electrostatic, electro-magnetic, magnetic, and chemical phenomena.

When a conductor forming part of a circuit is moved across the lines of force in a magnetic field, a current of electricity flows round the circuit. It is now generally accepted that when a magnetic field is established, some kind of a strain is set up in the ether. Without attempting to invent a new ether, let us assume that it is a continuous elastic medium, whose resistance to shearing is much less than that to compression or extension, and let us assume that the strain in a magnetic field is of the nature of a change of density from one point to another. A uniform magnetic field would be one in which the density changes uniformly,

and can be represented by the lines in fig. 1, which get closer together as the density increases downwards. Let the outer circle represent the section of the conductor, and the small circle the section of a molecule capable of rotation. The lower half of the molecule being immersed in the denser ether, must be assumed to meet with more resistance than the upper half, consequently when the conductor is moved to the right, the molecule will receive a clockwise rotation, when to the left a counter clockwise rotation, when upwards or downwards no rotation, since the resistance to motion of each half of the molecule is then the same. We suppose that every molecule has a certain grip on the ether, and that when it rotates it will drag the ether round and strain it in all directions, as in fig. 2. The force of restitution of the ether will be directly proportional to the displacement. When a molecule starts from rest and gets



FIGS. 1 AND 2.

up an angular velocity, ω, we suppose that during the increase or decrease of ω, the strain on the ether increases or decreases, and that when the angular velocity is constant, the pull on the ether, and consequently the strain is constant. In other words, if ω is the angular velocity, the displacement will be $= \int \omega \, dt$, and the force of restitution $= k \int \omega \, dt$. If we consider the end of a molecule (see fig. 3), it will be seen that the rotated molecule will put a twist on a portion of the ether. The resistance of the ether to shearing being much less than that to compression or extension, if we have a complete material circuit, and some of the molecules of this circuit are rotated in a given direction, the ether along the axis of rotation will be twisted, the twist will be propagated each way, and a ring of the ether will be rotated and a vortex ring formed. This vortex ring will lay hold of all the molecules in it, and rotate them. An electric current must be regarded as a collection of ether vortex rings round

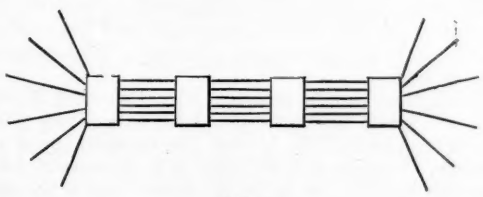


FIG. 3.

the circuit, each vortex ring rotating in the same direction, and carrying round with it, or rotating all the molecules it lays hold of. The molecules thus appear to be geared up endwise all round the circuit. A dielectric or bad conductor is a material in which the vortex ring is formed with great difficulty, or in which the resistance to shearing is very much increased. A good conductor is one in which the vortex rings can easily be formed, and easily carry round or rotate the molecules. When there is no complete material circuit, or when there is an air gap or interposed dielectric, the vortex ring cannot be formed, and the molecules will only rotate till the turning moment, due to our conductor (fig. 1) moving across the magnetic field, is equal to the back pull of the ether; or, what is the same thing, there will only be rotation of molecules in the circuit, whilst the velocity of the conductor in the field varies. When there is a complete circuit, the chains or strings, or rings of molecules, will continue to rotate as long as the conductor moves across the field.

The work done on the moving conductor is used up in three ways:—

1. In producing energy of rotation of molecules.

2. Supplying the energy dissipated in heat in the conductor.

3. In storing up energy in the ether.

1. The energy of rotation of the molecules

$$= \Sigma \tfrac{1}{2} m \omega^2$$

$$= \tfrac{1}{2} \mathrm{M} \omega^2 = \mathrm{E}$$

where m is the moment of inertia of a molecule, and ω the angular velocity. This summation includes not only all the molecules in the circuit, but also all those molecules in the field which will be rotated as explained later on. The time rate of change of energy of rotation is

$$\frac{d\,\mathrm{E}}{dt} = \frac{d\,\mathrm{E}}{d\,\omega} \cdot \frac{d\,\omega}{dt} = \mathrm{M}\,\omega \frac{d\,\omega}{dt},$$

and the change of energy in time dt

$$= \mathrm{M}\,\omega \frac{d\,\omega}{dt}\, dt.$$

2. According to the mechanical theory of heat, the molecules of a body are constantly moving or vibrating and colliding one with another. The average linear velocity is proportional to the temperature and the quantity of heat to Σ *vis viva* of the molecules. If the molecules be not smooth, they will have a certain amount of rotation as well as linear motion. By moving the conductor (fig. 1) across the field we impart additional rotation in a fixed direction to certain of the molecules, and the effect of the collisions will be to diminish this rotation and to transform a portion of the energy of rotation to energy of translation; that is, to heat the conductor. This was pointed out by Prof. Dolbear. If a molecule rotating with an angular velocity, ω, collide with one rotating in the same direction, it will lose a portion, say, $\frac{1}{n}$th of its energy of rotation; if its angular velocity be brought up to ω again, by external means, at the next collision it will again lose $\frac{1}{n}$ th of its energy of rotation, so that if the angular velocity be kept constantly ω, and there are m^1 collisions per second, the energy of rotation lost per second will be $\frac{m^1}{n} \frac{1}{2} m \omega^2$. The total amount of energy transformed per second from energy of rotation, or electrical energy to energy of translation or heat energy, will be:

$$\Sigma \tfrac{1}{2} \frac{m^1}{n} m \omega^2 = \tfrac{1}{2} \frac{m^1}{n} \mathrm{M} \omega^2.$$

The amount of heat generated in time

$$dt = \tfrac{1}{2} \frac{m^1}{n} \mathrm{M} \omega^2 \, dt.$$

This includes all the heat generated in induced currents.

3. The work done on the ether can be expressed as follows:—The displacement caused by one rotating molecule $= \int \omega \, dt$. The force of restitution $= k \int \omega \, dt$. and the distance through which the force of restitution must be overcome in time $dt = \omega \, dt$; hence the work done by each molecule $= \omega \, dt \, k \int \omega \, dt$, the total work

$$= \Sigma \omega \, dt \, k \int \omega \, dt$$

$$= \mathrm{N} \omega \, dt \, k \int \omega \, dt,$$

where N depends on the number of molecules rotated or displaced. This work includes the setting up of all electrostatic and magnetic fields.

Our source of energy is the conductor which is moved across a magnetic field. Consider one molecule, the force acting on it is the resultant pressure, p, on the molecule, and it acts on an arm, the length of which, r, is the distance of the centre of pressure below the centre of the molecule (see fig. 4). The distance through which this pressure, p, acts in time, dt, is $r \omega \, dt$; therefore, the work done in time, dt

$$= \Sigma r p \omega \, dt = \mathrm{N}^1 r p \omega \, dt,$$

where N^1 is the number of molecules in the magnetic field.

The equation of energy then is

$$\text{M}\,\omega\,\frac{d\,\omega}{dt}\,dt + \tfrac{1}{2}\,\frac{m^1}{n}\,\text{M}\,\omega^2\,dt + \text{N}\,\omega\,dt\,k\int\omega\,dt = \text{N}^1\,p\,r\,\omega\,dt. \quad (1)$$

This is identical with the equation of energy for an electric current, viz.:

$$\text{L}\,\text{C}\,\frac{d\,\text{C}}{dt}\,dt + \text{R}\,\text{C}^2\,dt + \frac{\text{C}\,dt\int\text{C}\,dt}{\text{K}} = \text{C}\,\text{E}\,dt. \quad (2)$$

We have thus established the fundamental equation of electro-dynamics, on the supposition that electricity is a rotation of molecules.

The strength of the current, C, corresponds to angular velocity, ω. The self-induction of a circuit is the sum of the moments of inertia of the molecules of the conductor and of the molecules set rotating throughout the fields. It is clear that when there are no rotating molecules in the field the self-induction will depend on the volume of the circuit only; also that if there are large masses of molecules in

Fig. 4.

the field to be rotated, the self-induction will depend more on the field than on the circuit. The resistance is shown to be a function of the temperature, since both m^1 and n depend on the temperature; it is also shown to be proportional to the length, since m^1 the number of collisions will depend on the length; it will also be inversely as the cross section, because the vortex rings will crowd together in a smaller section, and the number of collisions will increase in proportion as the area diminishes. The capacity of an electric circuit is shown to be inversely as k, which is the specific inductive capacity of the medium. The electromotive force, E, corresponds to a turning moment, as we should expect when current is an angular velocity; it is proportional to the dimensions of the conductor moving in the field, and to the strength of the field, p. Suppose a portion of our circuit conveying the current be placed in a magnetic field; referring to fig. 1, if the rotation of the molecules be clockwise, the part of the circuit will move to the right, and with the same velocity as the generating conductor, fig. 1, so long as it meets with no resistance; but if it is made to do work, its linear velocity will diminish, and ω will tend to diminish, if ω be kept constant by the generator, the effect of the diminished linear velocity of the motor will be to put a couple on the rotating molecules in the direction opposite to their rotation, otherwise there will be a back E.M.F.

To make equation (1) complete, a term $\text{N}''\,p'\,r'\,\omega\,dt$ must be added to the left-hand side, to include the work done by a moving part of the circuit.

(To be continued.)

A NEW PATENTED ELEMENT.

Whilst in America Stephen A. Emmens is pretending to make gold out of silver, or, in other words, to construct one element out of another, though he is careful to keep his secret process out of the Patent Office, we find that in France Prof. Barriere has patented a new element. We should think this is the first time in the history of the Patent Offices of the World that anyone has come forward with a patent element. Even our own Patent Office, which gives such fatherly attention to the *perpetuum mobile*, and similar wild impossibilities, has probably never been called upon to grant a patent for a new element. We are sure, however, from what we know of our own Patent Office, that it will do so with alacrity when the occasion arises. They manage these things differently in Germany and in America. A recent issue of the *Chemical News* devotes a page or so to a report on the complete specification describing the new patented element, which has been named by Barriere "Lucium." It is quite impossible, however, to gather from this specification any information of value concerning the properties of the new element, except that it is going to be used in connection with incandescent gas lighting, and will, of course, effect the usual revolution. It is rather a pity that this new element could not have been handed over as a free gift to the gas industry; it might have been the means of taking off that extra 2d. per thousand which usually rankles in the breast of every London householder. As for the man who claims to make one element out of another, or transmutes silver into gold, we are afraid we are doing Prof. Barriere an injustice by referring to him in the same paragraph. The *Engineering and Mining Journal* continues to publish meaningless letters from Emmens, which appear to us to be designed only for the purpose of obtaining notoriety, and possibly of attracting capital out of the pockets of such giddy investors as those who sank so much a few years ago over the Keely motor and electrical sugar. If this is not the object, we should like to know what is.

INTERIOR WIRING.*

The Three-wire System.

If the positive terminal of an incandescent dynamo is connected to the negative terminal of a similar machine, the two are said to be in series and the available voltage at their terminals is equal to the sum of the voltages of the two machines. In this case, assuming the system to be one of 110 volts, this potential difference would be twice that, or 220 volts. If we should connect across the 220 volt terminals a 110-volt lamp, the latter would illuminate to a dazzling brilliancy for a few moments and then burn out, or it might even explode, throwing glass in all directions. If two lamps in series are connected across these terminals, they will burn at their normal brilliancy provided they are exactly alike, and it is easy to see that a system could be devised with a voltage of 220, by using two lamps in series instead of one as diagrammatically indicated in fig. 1. Such a system would have a number of disadvantages. If one filament should fail, two lamps would be extinguished. If both lamps were not of exactly the same resistance, the voltage would not divide equally between them, and one would be too bright while its mate would be too dim. Thus the one would have a fore-shortened life and the other would burn at a very uneconomical efficiency. Two lamps must thus be used.

This system has the important advantage that it requires only one-fourth of the copper that an ordinary 110-volt system requires. This is best demonstrated by a simple problem. Suppose that 60 lamps at a distance of 100 feet from the bus-bars are to be fed with a loss in the wires of 5 per cent. of the total energy, the normal voltage of the system being 110. Applying the well known rule,

$$\frac{\text{Line loss in volts}}{\text{Lamp feet}} = \frac{5{\cdot}5}{6{,}000} = {\cdot}000917 \text{ ohm}$$

per foot for the proper wire.

With the 220 volt system, each lamp sends its current through another before returning it to the bus-bar and thus ·5 ampere suffices for two lamps instead of one as with the other system; thus only half the current is to be transmitted at double the voltage. Now as to the energy lost in transmission. In this case the volts line loss is 5 per cent. of 220 or 11 volts and as 15 amperes will supply the lamps the watts lost will be 165. Similarly in the other case 30 amperes flowed and 5·5 volts were lost in transmission, making the watt loss 165, the same as with the 220 volt system. The proper size of the wire would, therefore, be as follows:—

Resistance of line $= \frac{11}{15} = {\cdot}733$ ohm and the resistance per foot will be $\frac{733}{200} = {\cdot}003668$ or exactly four times as great as with the 110-volt system, and therefore requiring a

* *American Electrician.*

wire only one-fourth as large. To come to actual sizes, the wire for the 220 volt system would be No. 15 B. and S. and would perform the same service as a No. 10 wire in the 110 volt system.

In spite of numerous disadvantages which this system possesses, the great saving of copper that it affords has been a substantial consideration, and several modifications have been made to eliminate some of the more prominent objections while retaining in a marked degree the great merit saving of copper.

Among other methods the device shown in fig. 2 was tried. This idea is to connect together the portions of the circuit between the lamps by a third wire.

This obviates the necessity of turning two lamps on when only one is desired, and adds a little copper to the system. However, the system must be very nearly balanced or otherwise the lamps on the side where there are few would burn much brighter than the lamps on

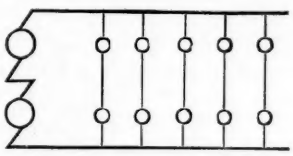


FIG. 1.—220 VOLT SYSTEM.

the side where there are many, and this objection has proven serious in practice. In fact, this method was only a makeshift to avoid the three-wire patents.*

The three-wire system, pure and simple, merely embodies the device of connecting the middle wire of the system just described, to the common terminal of the two dynamos. This obviates every difficulty of operation as far as the lamps are concerned. Unevenness of lamp load merely throws more load on one dynamo than on the other, but in no way affects their operation.

Suppose that a three-wire system existed where all of the lamps on one side are lighted and none on the other. It is obvious that if it were the positive side the current would

FIG. 2.—MODIFIED 220 VOLT SYSTEM.

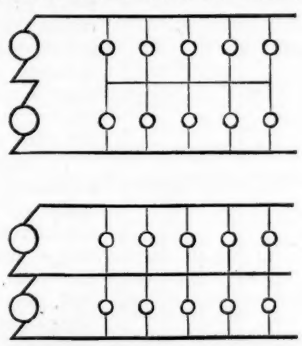


FIG. 3.—THREE-WIRE SYSTEM.

pass out through the positive wire and return through the middle or neutral wire. None whatever would return through the negative wire, because it is disconnected and the corresponding dynamo will have no load. Now, if a single lamp be turned on on this side, a load is thrown on the dynamo and the current for a single lamp will leave the neutral and flow to the place of lower potential through the negative return wire and dynamo. As the lamps are turned on one by one, a proportionate amount of current leaves the neutral to return by the negative wire until at last when the number of lamps on both sides are equal, no current flows therein because the potential difference between its ends is zero.

If lamps on the positive side are now turned off there will be a current in the neutral, but it will be in the reverse direction, and will increase in magnitude as the lamps on the positive side continue to be turned off.

If the system is well sub-divided—that is, the lamps are everywhere evenly distributed on either side of the neutral—the current flowing in the latter will be very small. In large installations, such as that of the New York or Boston Edison companies, the percentage of current in the neutral wire is but a few per cent. of the current in the outer mains, sometimes flowing in one direction and sometimes in the other.

In spite of the fact that the current that flows in the neutral wire is small, it does not follow that this wire should be small in proportion, for the loss of voltage in it is felt at the lamp terminals, causing inequality between the two sides.

Consider a case where the neutral is the same size as the outer mains. Assume that the lamps are evenly divided and that in each outer main there is 5 volts drop. The dynamos generate 115 volts each, and the lamps are fed at a voltage of 110. The neutral carries no current. Now, if all the lamps on one side are switched out, the current in the other main is not lessened, and an exactly equal current is now carried by the neutral. Five volts are lost in the outer main and five volts in the neutral. Thus the total loss is 10 volts as before, but *one set of lamps* must receive the voltage of one dynamo less 10 volts or burn at 105 volts. This is the extreme case and intermediate ones would show a proportionate loss in voltage. Hence a liberal neutral is desirable even though it often involves a large quantity of idle copper. A common size for the neutral is one-half or two-thirds the size of the outer mains in street systems, but even if it were the same size as the latter the total copper would only be three-eighths of that of a 110-volt system of the same extent, the line loss in watts being equal. It is poor practice to attempt to save on the neutral in interior wiring.

In wiring a building by the three-wire system, it is often desirable to make the neutral double the size of the outer mains. This enables service to be taken from the three-wire system, and by connecting the outer mains together and applying the terminals of a dynamo to one of the mains so connected and the other to the neutral, the system can be operated as a two-wire system.

The line loss in this case will be double the value when the system is operating on the three-wire mains, and must be supplied by the generating dynamos if the lamps are to burn at the same voltage as before. Thus, if a 110 volt system of lamps wired as just indicated were properly lighted by a three-wire supply having a pressure of 115 volts, the dynamos necessary to run the system on the two-wire plan would need a voltage of 120. The extra five volts are used by the neutral wire, which in the case of the three-wire system remained comparatively idle, but when the two-wire system is used carries double the current of one of the outer mains. In many large three-wire plants it is customary to put the neutral wire to earth, and this is important in interior wiring, as extra precaution must be taken.

* This device was used by Mr. W. Mackie in this country for ship lighting before the three-wire system was in use.—EDS. ELEC. REV.

COST OF ELECTRIC LIGHTING FROM PUBLIC AND PRIVATE SUPPLY.

BY F. J. WARDEN-STEVENS, A.I.E.E.

THIS subject has, of late, been brought into prominence by inquiries in the electrical journals; and as I have had several cases to consider, and have at present the matter before me, advising with reference to a private installation at a large Institution, it may not be out of place to publish some curves which I have prepared, showing the cost of electric lighting from supply mains and from a private plant, in order to show clearly when it is approximately advisable to adopt a separate plant.

In these curves, gas engine plants of less than 50 H.P. have been considered, and they will not apply to a much larger plant.

In their preparation assumptions have been necessary, and they are given in full; so that those who do not agree with the actual figures may correct them to their own satisfaction, and the curves will not lose their value owing to any uncertainty as to the kind of assumptions made.

The charge for attendance has been taken as £20, plus

£2 15s. 6d. per kilowatt installed, or what is the same thing, £20 plus 20d. per lamp on at one time, per annum; where plant is provided for the whole of the lights to be run at one time, and where 15 units per 8 C.P. lamp per annum are consumed.

An amount equal to 10 per cent. of this is added where plant is provided for half the lamps on at once, and 20 per cent. for quarter-lamps on at once. The charge for attendance is 20 per cent. higher when 30 units are used per 8 C.P. lamp per annum than when 15 units are used.

The capital expenditure on plant and works has been taken as follows (including accumulators):—

Kilowatts installed.	£
1·2	240
2·4	300
4·5	420
9·0	600
18·0	950

The interest on the capital and depreciation and repairs have been taken together as 10 per cent. of the outlay per annum.

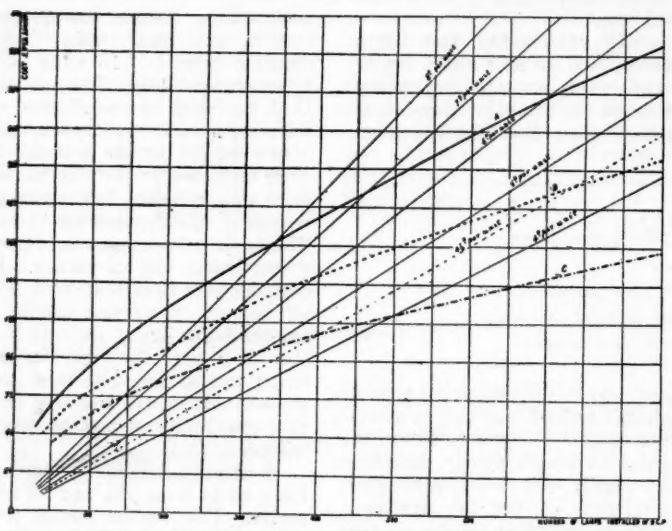
The charge for oil and stores is taken to be £2 10s. per kilowatt.

The gas consumption is taken to be as follows:—

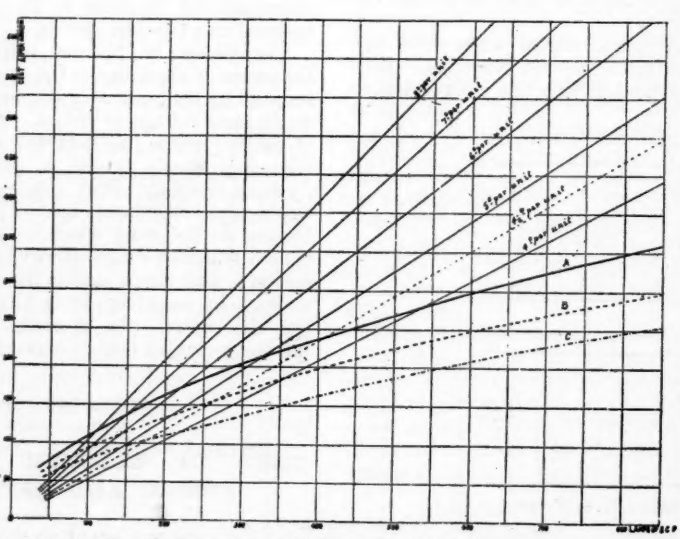
Kilowatts installed.	Cubic feet per unit.
1·2	56
2·4	53
4·5	49
9·0	42
18·0	32

Price of gas—2s. 6d. per 1,000 cubic feet.

The plant estimated for does not include any reserve, with the exception of the accumulators, as it is assumed that there is a connection with the supply company's mains. It has been questioned whether a supply company, or local authority, can be compelled to make a connection. I am of opinion that the undertakers under a provisional order must make a service connection for any applicant within the area of supply, and cannot demand a guarantee to pay for any fixed quantity per annum, if the applicant bears the cost of the connection.



Curve I.—With a Consumption of 15 Units per 8-C.P. Lamp per Annum.



Curve II.—Consumption of 30 Units per 8 C.P. Lamp per Annum.

A, Plant provided for all lamps on at one time.
B, " " " " ½ " " " " "
C, " " " " ¼ " " " " "

The cost of running the private plant has been taken to be the sum of:—

Interest on capital, depreciation and repairs, cost of attendance, oil, stores, &c., gas, accumulator renewals at 10 per cent. per annum, and rent of gas meter.

The cost for current only, from supply mains, is compared with the above. All expenses which are common to both, such as wiring, fittings, &c., have been excluded.

Explanation of Curves.

The horizontal ordinates show the number of 8 C.P. lamps (30 watt) installed, the vertical ordinates the cost per annum.

The thin line curves refer to current from supply mains, and the price per unit is marked on each.

The thick line curves show the cost for current when a separate plant is provided.

The full thick line shows cost when plant is provided for all the lamps to be running at once. The line dotted - - - - - shows cost when plant is provided for half the lamps to be on at once, and the line dotted — . — . — . shows cost when plant is provided for quarter-lamps to be on at one time.

The curves on Diagram 1 are worked out on a basis of 15 units per 8 C.P. lamp per annum, and those on Diagram 2 for 30 units per 8 C.P. lamp per annum.

Example 1.—To find the least number of lamps which can be economically worked from a private plant, where current can be obtained at 4½d. per unit.

It is evident that a line drawn representing the cost of current at 4½d. per unit (see thin dotted line) will cut the thick ones at three points on each sheet:—

Diagram 1.

15 units per annum.
(*a*) All lamps on at once, about 1,200 lights.
(*b*) ½ lamps on at once, about 740 lights.
(*c*) ¼ lamps on at once, about 400 lights.

Diagram 2.

30 units per annum.
(*a*) All lamps on at once, about 410 lights.
(*b*) ½ lamps on at once, about 275 lights.
(*c*) ¼ lamps on at once, about 175 lights.

It is also evident that these numbers of lamps can, under the different conditions, be run at the same cost by either method.

The highest estimate is 1,200 lamps, and the lowest comes out at 175 lamps of 8 C.P. This result explains to some extent the widely different results given by different experts to the same question in the Electrical Review of the 25th ult.

If, however, the units consumed per 8 C.P. lamp per annum and the maximum number of lamps usually required at once, are specified, the number of lamps can be given accurately. Suppose 22 units are used per 8 C.P. lamp per annum, and that half the lamps are required at once, then the number is the mean of the two, line (*b*), *i.e.*, 740 and 275. Result: 500 lamps (approximately).

Owing to the anxiety caused by a private plant, I should say that, under the above conditions, it would pay to lay down a private plant if there is an equivalent of 600 8-C.P. lamps connected.

In any case where the units consumed are less than 15 or more than 30 per annum, the method here described, of taking proportional parts, will not apply, and the problem must be worked out separately.

Example 2.—To find the annual saving by running a separate plant for 400 8-C.P. lamps, using 30 units per annum (or about 1,000 hours burning), where a supply can be obtained at 4½d. per unit.

Referring to Diagram 2, thin dotted line, the cost of current is £236. The cost, if a private plant is used, is

(*a*) £240; (*b*) £190; (*c*) £162.

Thus the saving would be nothing if plant is provided for all the lights at once; £46 per annum if plant is provided for half the lights at once, and £74 per annum if one-quarter of the lights are provided for at one time.

If the number of units is between 15 and 30 per 8 C.P. lamp per annum, proportional parts may be taken between the results of diagrams 1 and 2, as in the last example.

It will be noticed that the ratio of the plant provided to the total number of lights, has a very great effect on the point when it will pay to provide a separate plant. It is not necessary to instal plant sufficient for the greatest number of lights ever on at once. The plant can be laid down sufficient for the usual maximum; rock-over switches can be placed on each sub-circuit, so that one or more circuits can be switched over to the mains in case of an abnormal load, or in case of any breakdown of the plant. These rock-over switches could also be used at times of fairly light load, when the demand is too low to warrant the starting of the engine, and when it is too heavy for the accumulators to undertake.

The points which I wish to emphasise are:—That *the units consumed per* 8 *C.P. lamp per annum*, and *the usual maximum demand* have a great deal to do with the question of *when it will pay* to instal a separate plant, and that, unless these figures are known, no answer can be given to the question.

The effect of a "Wright" system of charging would be to decrease the slope of the 30-unit curves from the mains, more than the 15-unit ones, but the lines would still be straight. Any person can make allowance for this if the scale of charges is known; also there would have to be three sets of thin lines, one when all the lamps were on at once, one for half the lamps on, and one for a quarter of the lamps on at once (as the prices would be different in each case), to correspond with the three thick curves.

In conclusion, it must not be imagined that these curves are intended to take the place of the advice and assistance of a consulting engineer, as there are many special conditions, considerations, and questions which cannot be introduced into a curve; but I think they will prove of value if used intelligently, and if the assumptions are studied carefully before the results are taken for granted, to those who wish to know when (given ordinary circumstances) it will pay to put down a separate plant. They will be even more useful to those who wish to see what effect the varying of the units consumed per lamp and also of the maximum demand, has upon the point when it will pay to discard the public supply.

IMPROVED MIRROR SPEAKING INSTRUMENT DESIGNED ESPECIALLY FOR USE ON BOARD SHIP.

By J. RYMER-JONES.

THE improvements consist in

a. The method by which received signals can be varied in size.

b. Reversing quickly the direction of signals.

c. Increasing the sensibility considerably beyond that obtainable by the ordinary mirror speaking instrument.

d. Rendering the instrument *dead-beat* when worked on practically short-circuit.

a. The size of cables is usually modified, to meet the requirements of the length of cable in circuit, either by a variable water resistance; by shunting the coils; or by connecting up one, two, or more of the several coils with which the instrument is sometimes provided.

This can be done by the above instrument more effectually and speedily by simply moving the circular magnet round in either direction.

The size of received signals can be reduced by this means from the maximum to any size until the instrument is quite unaffected. For suppose the poles N and S be turned round through a right angle, *i.e.*, to the vertical position shown by the dotted line; the small strip of soft iron, *i*, at the back of the mirror entirely loses its induced magnetism, and is consequently uninfluenced by currents passing through the large coil, *c*.

b. Moving the circular magnet round still further, the soft iron behind the mirror receives the *opposite polarity*, which is increased until the circular magnet poles are again in a line with terminals, *t* and t^1; and currents passing through the coil, *c*, will cause the mirror to be deflected in the opposite direction, *i.e.*, the signals become reversed.

The permanent magnet is separated from the brass cylinder which encloses the coil by a strip of flannel, or felt, and can easily be moved around by the hand.

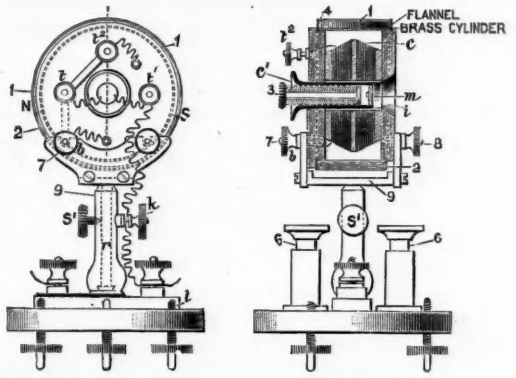
When the ship calls up the shore, or *vice versâ*, during a cable repair, it is important, for the safety of the cable, to economise every minute in rough weather. At such a time an expeditious way of regulating the size of received signals, or reversing the direction, if need be, is desirable.

c. Increasing the sensibility of the speaking instrument is useful when received signals are weak, owing to the existence of a *partial earth* fault between the ship and shore. Augmenting the sending battery on such an occasion is better avoided if the size of signals can be made sufficiently large by other means.

The simple device of Mr. Walter Judd, of the Eastern Extension Telegraph Company, of inserting a rod of soft iron into the mirror tube behind the mirror magnet is a very decided advantage; and this device has been rendered more effectual still by winding the soft iron core with fine silk-covered copper wire, c^1, and connecting it up in series with the mirror coil, *c*.

It will be apparent that the circular magnet not only induces magnetism in the soft iron piece, *i*, attached to the back of the mirror, but also gives similar polarities to the two *sides* of the cheek 3 at the end of the soft iron core immediately behind the mirror.

Since the mirror needle, *i*, and the end of the soft iron core have, therefore, similar polarities opposed to each other, the tendency of the repulsion at both ends of the needle



1, Permanent magnet.
2, Boxwood ring.
3, Soft iron bobbin.
4, Wire lashing to hold 1 and 2 together.
6, Spare tubes.
c, Mirror coil.
c^1, Auxiliary coil.
m, Mirror.
i, Piece of soft iron, diameter of *m*.
k, Insulated terminal.
l, Ebonite block.

NOTE.—By loosening screws 7 and 8, the coil with magnet, &c., &c., is removable from its stand 9. Magnet ring moves easily around the brass cylinder. Thin flannel between.

(when no current is passing through coil *c*) is to keep the plane of the mirror, *m*, parallel to the scale placed in front of it, and to overcome any slight torsion in the suspension fibres.

When a received signal passes through coil c^1, surrounding the soft iron core 3, the two ends take opposite polarities. Since, however, the end near to the mirror has already both N and S polarity in the direction of the permanent magnet poles, the effect of the additional magnetism developed *longitudinally* by the received currents is to intensify the magnetism on one side and to weaken the magnetism on the opposite side.

The result is that the mirror needle is now repelled more by one side than by the other; and the deflection produced by the received signal passing at the same moment through the instrument coil, *c*, is thus increased, because coils *c* and c^1 are so connected up that both influences combine to move the mirror in the same direction.

Experiments with the instrument show the relative sizes of the signals to be as follows, when working through an artificial cable having a conductor resistance of 3,083·$^{\omega}$, and

a capacity of 304 microfarads, and also an additional 10,000 units in circuit.

	Throw produced by signal.
Coil c only, as usually employed ...	= 34 divisions
„ c^1 „ with coil c on short-circuit	= 34 „
„ c „ with the electro-magnet in the mirror tube as shown, but not having its coil connected up	= 62 „
„ c and c^1, both connected up in series	= 87 „

The sensibility is thus increased 82 per cent. by using the soft iron core, 3 in conjunction with the instrument coil, c, and 156 per cent. by using c^1 as an electro-magnet in circuit with coil c.

(*d.*) When speaking through a very short cable, *dead-beat* signals may be obtained by connecting a wire between terminals, t and 7; or the brass strap may be moved over to terminal 7, as shown by the dotted lines, so as to have the electro-magnet coil only in circuit.

As the transmitting key puts this coil on short-circuit after every signal, the *extra* currents induced in the coil and core have a very considerable damping effect which helps to steady the signal.

On account of the tube being practically closed at one end by the electro-magnet, the movement of the mirror is further damped by the air. This is more marked by closing the front opening of the tube also by a cap provided with a glass disc to admit the light to the mirror.

The beneficial effect of the air when so confined is naturally much more noticeable in the case of sharp signals received when there is little or no capacity in the line circuit to produce retardation.

When working with no other resistance except that of the electro-magnet coil in circuit, the signals are remarkably *dead-beat* and easily legible. On the other hand the instrument may be made unusually sensitive as shown above; and since signals may quickly be modified in size, or reversed in direction by merely moving round the circular magnet, 1, the instrument is found to offer substantial advantages over the form of speaking instrument in general use.

The circuit through the coils, c and c^1, is as follows:—

Left terminal on base board; brass upright; through clamp screw, s^1, to central rod, r (for adjusting the height of the mirror to the lamp); brass bed, b, on which the magnet and coil rest, to clamp screw 7, and one end of coil, c, connected to it; then around coil, c, to the top central terminal, t^2; across the brass strap to t; through electro-magnet coil, c^1 to t^1, whence a wire connects with the insulated terminal, k, to the instrument terminal on the right of base board.

By loosening the clamp screw, s^1, the mirror may be raised or lowered; and also turned round horizontally, so as to bring the spot of light on any part of the scale.

This form of mirror speaking instrument has been adopted for use on board the Silvertown Company's repairing steamers, and is found very serviceable. The two extreme conditions under which the instrument can be used enables the ship, after cutting a cable to speak in either direction, *i.e.*, through a long section, or on practically short circuit—if the repair be close in shore—instead of having to change over to a Morse instrument.

CORRESPONDENCE.

A Patent Museum.

I read with interest the letter of Mr. Sinclair Fairfax in your issue of December 11th, 1896, respecting "A Patent Museum," and am rather surprised that no support has so far been given to his suggestions by your numerous readers.

I must say I cordially agree with the major portion of his letter, and as I consider the matter to be one of importance, venture to make a few remarks relative to the subject.

The sum of £5,000 which Mr. Fairfax proposes as sufficient, is but a very modest percentage of such a magnificent yearly surplus as was obtained in 1895, viz., £96,500, and such appropriation for the public benefit out of it is well deserved by inventors, and I fail to see any objection the authorities could raise against such a proposal.

Nor should matters stop here; taking into consideration such a satisfactory state of affairs, I am of the opinion that it would not be out of place if other portions of such surplus were set aside, with the object of giving inventors some guarantee for the fees they have paid to the authorities for the protection of their inventions.

I should propose, for instance, the maintenance of an efficient expert staff of examiners, whose duty would be to follow on similar lines the methods adopted by their confrères in the German and United States Patent Offices.

It may be argued that such already exist, but I fear such existence is in theory only.

The prevailing system in this country leaves much to be desired, and one has no need to look far beyond it for the cause of such a large yearly surplus.

The granting of a British patent practically gives the applicant no guarantee for the fees he has paid for lodging his specification, and his patent when sealed, is practically worthless until a test case has been tried and the validity of his patent upheld by the costly intervention of the Law Courts. A poor inventor is thus severely handicapped.

True, eminent counsel's opinion on the validity of a patent is very often accepted as sufficient by capitalists anxious to acquire patent rights, but even this is a costly process.

British patents are apparently granted promiscuously for schemes which are devoid of novelty, and a question of priority appears to have nothing to do to militate such grants, unless such prior patentee or his assignees (*i.e.*, the persons directly interested) oppose it when in the opposition stage.

Applicants for British patents whose specifications have been accepted, and consequently imagine they are secure, are thus living in a fool's paradise, only to be awakened to the true facts (or I might say their insecurity) when the imitator comes on the war-path.

Contrary to this haphazard method of procedure the German and United States Patent Offices institute a thorough search (not a nominal one), and the grant of a patent in either of these countries is of value, and may generally be taken as a proof of its validity, in fact is often looked upon as such by probable buyers, who are either negotiating for its sale outright, or for taking up the manufacture on royalty.

If the application in its entirety is not accepted, the applicant I believe is, as a general rule, allowed to amend his claims according to the wishes of the authorities, those claims objected to being abridged, or eliminated altogether, and those possessing novelty passing muster, the patent being granted for the application in its amended form.

In this country in many cases it simply amounts to a commercial speculation. An article is patented, the only object apparently being to stamp goods as such which are manufactured in accordance with it, and so throw dust in the eyes of the uninitiated, when possibly all the time it is an old idea and the subject of a prior patent. If it is so, the manufacturers take their chances as to whether its validity will be questioned or not.

It is, indeed, humiliating to national pride to constantly receive circulars from foreign patent agents, in which statements appear addressed to their clients, guaranteeing the firm's ability to obtain a British patent with little trouble. What does this signify? Simply that the British Patent officials offer no obstacles, and practically accept anything and everything, provided the necessary fee accompanies the application, and the regulations set forth by Act of Parliament have been complied with.

Again, to quote from a circular issued by a British firm of patent agents, which I have before me:—"Provisional protection. This is in no sense a patent. In Bates *v.* Redgate, the Court decided that:—'The existence of a prior provisional specification for any given invention was not a ground, in the absence of fraud, to refuse a second provisional specification for a similar invention when filed by another inventor, and if the second applicant first obtained the grant of a patent, such patent would invalidate any patent subsequently obtained by the first applicant on his prior application.'"

Granted the foregoing to be correct, surely there is something needing reform here, otherwise of what use is there in taking out a provisional patent, if a later comer can complete a similar specification before the original inventor, and in-

validate that of the latter? (It is not a probable state of things, but certainly a possible one, and, in all cases, it might not be possible to trace the result to fraud, in order to obtain evidence to annul the patent granted to the second applicant for provisional protection.)

It practically amounts to a farce in the fullest sense of the word, and an expensive one at that, constituting a trap to the unwary, who imagine a provisional protection to be a protection in more than name only.

Where a further portion of the annual Patent Office surplus might be advantageously (and conscientiously) made use of is as follows:—In the present state of things, if an applicant has received provisional protection, no notice is given him by the authorities when his provisional lapses; nor, in the case of a patentee, is any notice given him as to when the necessary payments become due, consequently such patents often lapse owing to inadvertence, or a too blind belief in the infallibility of a patent agent's memory; or else if remembered too late, one is mulcted into paying a comparatively heavy fine for an enlargement of time in which to make the necessary application.

If the Patent Office is run on such commercial lines as one would suppose, judging from the satisfactory surplus, is it not due to inventors that the payment of the necessary fees should entitle them to having notice sent them, say two weeks before the last day payment is accepted, in a similar manner to that adopted by insurance companies, &c.

Gus C. Lundberg.

Block Signalling.

I have to thank you for the prominent notice that, under the above heading, you have taken of my system of railway signalling, and to ask that you will kindly allow me to make a few observations in reply.

First let me point out that your description of the *modus operandi* hardly conveys, to my mind, a correct idea of what takes place. You say the road magnets are caused "when passed over by a vehicle equipped with the necessary apparatus, to *evolve* a current in one of two directions. This current actuates a relay, and the relay actuates a bell. The magnets placed in one position *generate*—say, a positive—and in the other a negative current." This would seem to imply that I had fallen back on the old idea of *inducing* a current in a coil carried by the train past the road magnets, a method entirely useless when the train is standing or moving slowly, and which at fast speeds can only give an alternating current, and therefore one signal instead of two.

My apparatus is much simpler than this, the polarised contact-making needles being actuated directly by the field proceeding from the road magnets, which is collected and condensed upon the needle by the iron armature in which it is mounted; the armature bars taking the place of the electro-magnets in an ordinary polarised relay. The needle is balanced, and held off its contacts by means of the polarising magnet, and is thrown over to one side or the other, so as to close one or other of two local circuits, according to the polarity of the road magnets passed. The polarity of the road magnets is under the control of the signalman. Two needles are placed in an armature merely as a safeguard; either needle suffices to make the circuit, and an indicator shows if either needle fails (which has not yet occurred in three months with the first apparatus made), while the other needle continues the proper working of the signals.

Now as to the uses to which my apparatus may be put. I firmly believe that my one system is capable of doing all, and more than all, that is done by the three present systems of semaphores, coloured lights, and detonators, and its cost on any new railway would be enormously less; but it is especially as a substitute for the present crude and barbarous method of fog signalling that I look for its immediate application. With all its trouble and expense, fog signalling is at present conducted on the assumption of all right when no signal—an assumption never permitted when the engine driver can see where he is going. This assumption *must* be made when only one signal is used. Anybody can at once see that it is far safer that the "line clear" signal should be a positive one, and not simply the absence of a "danger" signal. That the present system is very defective is, I believe, universally acknowledged; that the Board of Trade so consider it is shown by the following extract from a letter I received from the Railway Department last May:—"I am directed by the Board of Trade to . . . . state that the Board would be glad to see some improvement in the present system of fog-signalling, and to point out that the matter has on occasion been dealt with by the Railway Inspecting Officers of this Department in their reports on certain railway accidents. I am further to observe that if a mechanical system of this nature" (referring to my apparatus), "perfect and reliable in all respects, can be found, the Board see no reason why it should not supersede the existing system."

Your question as to whether it is judicious "to employ two forms of signals, and so reduce the responsibility which attaches to the existing form of signals," I cannot understand. Which is the existing form—semaphore, coloured lights, or detonators? By substituting for the detonating fog signals a miniature semaphore on the engine as I propose, you would simply abolish one of the three systems now in use on every railway in the country.

As to other inventions for signalling on the engine having been brought out, and it's being "notable that not one has found a footing," I can only say that they every one depend upon mechanical contact between something on the moving engine and something on the ground, and it stands to reason that no railway engineer in his senses would take the responsibility of recommending for adoption apparatus which in some cases would have to be actuated mechanically by something passing at the rate of, perhaps, 120 feet per second, or, in the case of electric signalling, would involve the making of electric contacts at this speed, and the laying on the road of unprotected bare insulated conductors, failure of current in which (or of contact with which) would lead to the non-receipt of a danger signal.

Mine is the only two-signal system yet proposed in which there is absolutely no contact between travelling and stationary parts. Further, every part of my apparatus may be *completely* boxed in and protected from moisture and dust.

I cannot, without trespassing too much on your space, enter fully into the construction and capabilities of my apparatus, but must just refer to the matter of route indicating, my description of which you say you do not clearly follow, and apparently do not consider as of much importance. The object in view is not to signal to a signal cabin, but to the engine driver, which route a train is taking; and to do this without the interference of the signalman. The *Times* of Christmas Day, in an article on my system by a gentleman well known in the railway world, says of this plan:—"Even now there is one application of it" (the magnetic method), "so simple of explanation and so likely to be of practical use, that it must not be left unmentioned." Another gentleman (a very important man, whose name I do not feel at liberty to mention here) has told me in the course of conversation that he believes my patent for this method of route-indicating will prove "very valuable."

Finally, permit me to say that I do not propose to interfere in any way whatever with present methods of block working, except in the application of my apparatus to automatic block signalling in any case where this is desired.

W. S. Boult.

Manchester, *January 2nd*, 1897.

[We have pleasure in affording Mr. Boult's remarks in reference to our article of last week every prominence. The remarks are entirely explanatory, and we have nothing to add to our previous observations, beyond the fact that we are at all times pleased to see electrical agency employed in any capacity. We quite recognise that any reliable means by which the present system of fog signalling can be avoided would be an advantage, not only from an economical point of view, but in respect of the health of the men who have to attend during the time such weather prevails.—Eds. Elec. Rev.]

Personal.

With reference to the paragraph which appeared in last week's Electrical Review, stating that Mr. H. W. Ravenshaw had resigned the position of consulting electrical engineer to this company, I have to say that Mr. Ravenshaw

did not resign; the term for which he was originally engaged having expired.

We think it only fair to say that our relations with Mr. Ravenshaw have always been, and still are, of the most cordial nature.

P. R. Jackson & Co., Limited,
J. SLATER LEWIS, *General Manager.*

[The statement referred to was made on the authority of Messrs. Booth & Ravenshaw.—EDS. ELEC. REV.]

As the announcement of Mr. Ravenshaw's retirement from the position of consulting engineer to Messrs. P. R. Jackson & Co., Limited, Manchester, seems to have caused some misunderstanding, may we state that the feeling existing between the two firms has always been, and still is, of a most friendly character.

Booth & Ravenshaw.

Bristol Engines.

I have seen much in the technical press on the subject of American engines about to be used in the Bristol power station. But the only reason given for discarding the "Willans" type is that larger units are required and therefore the rope driven plant is to be replaced by direct driven! But seeing that the Ditton engine is eminently adapted for direct coupling and is now made in large sizes, some other solution must be sought and the question must either be one of economy or governing. I dismiss the latter idea, as every station engineer has watched the pointer of a speed indicator on a Willans engine and been surprised by the small amount of variation. If then it is necessary to go to the States for economical or durable engines, home engineers had better put their heads together, although I am foolish enough to believe that if open competition had been resorted to at Bristol English engineers would have held their own however stringent the conditions.

"Senex."

British Motor Syndicate.

In reply to Mr. Lorrain's letter in your last week's issue—I did not refer to the method of vapourising he describes, but it may be of interest to him to know that I experimented with it some time ago and found it of no practical value. I think this is corroborated by the fact of its not being in use, and I am sure Mr. Lorrain himself cannot have been successful with it.

I should like Mr. Lorrain to refer to his papers to find the exact date, as I think he is mistaken in fixing it so far back.

Walter Rowbotham.

The Telegraph and the Berne Convention.

In reply to Mr. T. A. Hill, I do not say that a complete set of mathematical symbols should be coded, but as many as are from time to time found to be needed. I contend that if the + sign is required to be transmitted, the word plus should not be substituted. A R is not used to signify the end of transmission in all services. There seems to be no well-defined rules accepted by all services. I think S N to be most generally used, and the signals S N, O K, R T, have been used indiscriminately for all the purposes mentioned by Mr. Hill since telegraphy began; but I am not wedded to any signal, and if E J is not good enough, another may be substituted.

I object to the letter S, as 3 S 4 may be mistaken for a mixed group instead of 3/4.

The official disuse of a signal does not, in my mind, condemn it. "G" is more easy to signal on a Morse or mirror key than "K," and it is as easy to punch, as is also I I as compared with B T.

With regard to the last paragraph, it will be a matter of great surprise to the members of the Conference to be told that it is out of the power of your Journal, or anybody else, to make any useful suggestion as to the Convention rules and regulations.

The Writer of the Article.

BUSINESS NOTICES, &c.

Advance in Price.—The Electrical Power Storage Company announces an advance in the prices of E.P.S. cells of about 5 per cent. from January 12th, in consequence of the increased cost of raw materials. A new catalogue is in preparation.

Annual Entertainment.—The annual entertainment given by the Edison & Swan United Electric Light Company, Limited, to their employés, is to be held to-night at the Queen's Hall, People's Palace, E. *Soiree* to commence at 5 o'clock.

Auction Sales.—Messrs. Debenham, Storr & Sons will sell by auction, on Tuesday next, the stock of Roger Dawson, Limited, electrical engineers and contractors, at 63, Berners Street, Oxford Street, W. See our "Official Notices" for particulars.

Messrs. Percy Huddleston & Co. will sell, by order of the receiver and manager in the liquidation of Bennett & Druce, on Thursday, January 21st, at Norton Street, Greengate, Salford, the stock of the said late firm, which comprises dynamos, motors, arc and incandescent lamps, switches, gas engines, &c. See our "Official Notices" for particulars.

Australian Telephones.—At the recent Inter-Colonial Postal Conference held in Sydney, a suggestion was brought forward by Mr. Jules Renard respecting telephonic communication between the capitals of Australia. The proposal was, according to the *Sydney Daily Telegraph*, to connect Brisbane, Sydney, Melbourne, and Adelaide by telephone, but it was found that the charge that would have to be made for conversation would be so high as to be almost prohibitory. The line from Brisbane to Sydney alone would cost £41,750. On the whole, therefore, it was thought that the population of the colonies was not sufficient to enable a work of this nature to be carried out at present, so as to make the thing remunerative at a reasonable charge to the public.

Bankruptcy Proceedings.—At the Cardiff Official Receiver's Office on Tuesday, the affairs were investigated of Thos. Maddren, electrician, trading as T. Maddren & Co., late of 47, Castle Arcade, and now of 32, High Street, Cardiff. The gross liabilities were estimated at £755 7s. 9d., of which the amount of £463 10s. 5d. was expected to rank. The assets were set down as £82 15s. 2d., leaving a deficiency of £380 15s. 3d. No resolution was passed, and the Official Receiver remains trustee.

New Year Greetings.—The Commercial Cable Company are, as usual, wishing everyone the compliments of the season. Their greeting this year takes the form of a nicely tinted card printed in several colours, showing the Commercial Cable Building, New York.

Change of Address.—Mr. A. F. Spooner, chartered patent agent, has removed to 323, High Holborn, London, W.C.

Drake & Gorham.—This firm has sent us a list of many of the installations carried out by it during the year 1896. The demand for electric lighting in small country houses has increased very considerably, and there is every prospect of 1897 being quite as satisfactory from this point of view. The list of houses lighted in town and country by Messrs. Drake & Gorham during the year, and which we have not space to publish *in extenso*, includes those of a number of eminent and titled aristocracy, including the Earl of Crewe, Lord Armstrong, the Marquis of Lansdowne, Judge Selfe, and prominent lawyers, authors, doctors, &c. The list of public buildings in various provincial towns is also a very excellent showing. The increase of work has necessitated the taking of an additional floor at Victoria Street. The "Jandus" arc lamp has sold well. There are stated to be 2,250 in daily use, and as the company's present machinery is inadequate to cope with the demand, a duplicate plant has been ordered. Eighty-eight of these lamps are in hand for lighting the West Ham streets, 100 for Chatham and Rochester streets, and other orders in hand amount to nearly 1,000 lamps. Branches at Glasgow and Chester have been opened during the year.

Dissolution of Partnership.—The partnership heretofore subsisting between J. O. Grant and F. W. Cocks, carrying on business as electric light contractors at 43, London Wall, London, under the style of Grant and Cocks, has been dissolved by mutual consent. All debts will be attended to by J. O. Grant.

Electric Lifts.—All the electric lifts mentioned in our note on page 22, last week, were manufactured and fitted by Messrs. Easton, Anderson & Goolden, Limited.

Fire.—A destructive fire occurred in Cheltenham late on Sunday night at the Trusty Oil Engine Works (Messrs. Weyman, Hitchcock & Co., Limited), near the Midland Station. The damage is estimated at between £15,000 and £20,000. The fitting room contained a large number of engines in the course of completion, and several valuable lathes and engines, built by Messrs. J. Archdale and Co., Tangye Brothers, and Kendal & Gent, Manchester. Amongst the machinery destroyed were a dynamo and electric light plant, and a great quantity of finished work. The increasing demand for oil engines had led the firm to lay down extensive plant, and sufficient orders were booked to keep the men—nearly 150—in constant employment for six months, without any additional orders coming in. Efforts are being made to keep the men going in other parts of the premises.

Geipel's Steam Trap.—The Shillingford Works Company, of Wallingford, Berks., report that during the past year their business in these traps has increased rapidly, and that the output is over four times that of the previous year. In the list of the chief users are upwards of 30 of the principal electricity supply works in this country, as well as many of the more prominent engineering firms, including some of the largest builders of marine engines. The trap obtained a silver medal at the Rouen Exhibition.

Gas.—A gas explosion occurred on the 30th ult. at premises in Ferrier Street, Leith. A man was injured.

Johnson & Phillips.—This firm inform us that during 1896 they were very busy upon large contracts, including South African power transmission plants, alternators and lighting plant for home and foreign districts, and they are now constructing several alternators of 120 and 100 kw. capacity. In the cable machinery department the *Okinawa Maru* and the *Tutanekai* have been equipped, and a contract is now in hand for transforming a merchant vessel into a cable-laying steamer. The sales of arc lamps, carbons, the Perry meter, and vulcanised rubber cables, have also been very large and are rapidly increasing. The outlook for 1897 is very promising.

"Knowledge."—The January number of this excellent publication is before us. It is full of well illustrated, interesting articles on scientific subjects. The science of the Queen's reign is to be dealt with in a series of articles—the present issue containing one by John Mills, F.R.A.S., accompanied by a page of photographs of "illustrious philosophers of a bygone era." The paper is beautifully printed.

Lists.—Mr. James Dickson, of 48, Gray's Inn Road, W.C., has issued Section 1 of his new catalogue of dynamo and motor brushes. Prices for various lengths and widths are given.

We have had sent to us by Mr. A. W. Richardson, of Patricroft, a list, dated November, 1896, of the Richardson "J. R." arc lamp. The list contains descriptive details, illustrations, and prices.

Receiving Order.—In the Birmingham Court of Bankruptcy, on 1st inst., Mr. Registrar Parry made a receiving order in the matter of W. R. Ridings, of Albert Street, Birmingham, electrical engineer, and late of Fair View, Bristol Road, Bournbrook. Mr. W. B. Glasier, of London, is solicitor in the proceedings.

Removal.—With reference to the removal of Messrs. McGeoch & Co.'s showroom from 10, Berners Street to 11, Charing Cross Road, we understand that this is their only London address, and that they have absolutely no connection whatever with any other firm of the kind.

The Factory Act.—The Hastings Electric Light Company was, on 31st ult., fined 40s. for neglecting to fence in the fly-wheel of a steam engine and certain pulleys, which were stated to be dangerous.

Transformers.—The C.T.C. and Manufacturing Company, Limited, announce that they are now giving a great deal of attention to the manufacture of high efficiency transformers of all sizes.

Veritys, Limited.—From the beginning of the new year Veritys, Limited, are making a new arrangement with regard to their London business, by which their private and retail trade which has hitherto been carried on both at King Street and Regent Street, is being discontinued so far as King Street is concerned. At Regent Street, where the premises have been enlarged and rearranged, the whole of the private and retail business will in future be transacted. Mr. Ashford, the art director of the company, has, in accordance with this arrangement, left King Street and taken up his position at Regent Street, where, in conjunction with Mr. Humphries, the present manager, he will deal with the whole of the high class metal and fittings business. The Regent Street show rooms, now they are enlarged, may be said to contain a splendid exhibition of high class and special decorative electric light fittings, while the portfolios of drawings contain samples of metal work of every style and cost. The King Street premises, where extensive alterations have lately been going on, Messrs. Veritys propose to devote entirely to their wholesale business dealing solely with the electrical trade and their clients. A block of buildings which formerly were utilised for factories have now been decorated throughout, and by staircases communicating with their old show rooms, these now form complete and extensive suites, in which will be exhibited the catalogue goods made by the company, together with numberless fittings both of a plain and elaborate character, to meet every requirement of the electrical trade. In the same way Messrs. Veritys' electrical accessories department is being further extended, and in the early spring, as the structural alterations are completed, wholesale departments for the sale of wire, cables, casings, and electrical supplies of all descriptions will be added. Also a separate department is being established for dealing with motors, resistances, and general electrical engineering apparatus, in connection with which Mr. Lambert, formerly of the G.E.C., has been placed in charge.

ELECTRIC LIGHTING NOTES.

Australia.—The Narrabri Municipal Council recently accepted a tender for a loan for electric lighting. The *Sydney Mail* says that this action is likely to be disputed.

Tenders were recently sent in to the Moree Municipal Council for lighting the town by electricity. A sub-committee recommends that none of these be accepted, but that instead, Mr. J. O. Callender, electrical expert, be retained to report on the best method of lighting the town and draw up specifications on which future tenders will be based.

Blackpool.—The Electric Light Committee recommends that free wiring proposals be adopted.

Brierley Hill.—The Lighting Committee recommends that a special meeting of the District Council be held to fully consider the electric lighting question.

Bath.—A special meeting of the Electric Lighting Committee was held last week to consider the reply received from the Local Government Board as to the outcome of the inquiry lately held by their inspector into the application of the Urban Sanitary Authority for power to borrow £58,000 for electric light purposes, including the purchase of the old company's works and plant. The Board sanctioned a loan of £45,000 for the purchase of the works (for 20 years, instead of 30, as applied for), but the £13,000 required for the purposes of extension is refused, and must be made the subject of a separate application, the proposed extensions being scheduled and definitely stated. It was decided to take over the works early this month.

Bedford.—The Council last week resolved, on the recommendation of the Electric Light Committee, not to entertain the application of Mr. J. G. W. Aldridge, of London, to run electric cars in the Borough on the terms suggested by him. All gas lamps rendered unnecessary by the additional electric lamps are to be removed from the streets. The proposal of the Committee, to which we referred last week, to give each consumer of a certain quantity of current a lamp, was adopted.

Canterbury.—The Town Council, on Wednesday, resolved to apply to the Local Government Board for sanction to expend £23,000 in municipal electrical works.

Derby.—There will probably be an important discussion on the electric light at the next meeting of the Town Council, says the *Derby Mercury*, the committee having decided to ask the sanction of that body to a further loan of £20,000 for the development of that undertaking. The financial side of the situation is in rather a complicated condition. Last year the Local Government Board refused to sanction a charge on the capital account of £2,470, and with regard to this year's account the Borough surveyor has made an allocation to capital and revenue which the committee refuse to accept, on the ground that the charge to the latter is too much. The engineer's (Mr. Stewart) estimate is:—Machinery, &c., £10,250; mains, services, &c., £8,650; building, £450; accumulators, &c., £650.

Grantown.—A public meeting was held in the Public Hall the other day to consider the report on the schemes lately submitted by Mr. Middleton, of Aberdeen, and Mr. Stewart, of Glasgow, for lighting Grantown by electricity. By Messrs. Stewart's scheme the river Spey is tapped at a point 600 yards above Spey Bridge, and the turbine house is erected a little above the bridge; while by Mr. Middleton's the river is tapped about 300 yards further up, and the turbine house erected a little below the bridge. Mr. Stewart's scheme, which provides for a sub-station, with accumulators, and also for overhead wires on poles, would cost £4,500, or with underground wires, £5,300. Mr. Middleton's scheme, which provides for the accumulators in the turbine house and for underground mains, would cost £4,815. Mr. Burgess (the chairman of the meeting) further stated that there would be no great difficulty in raising the necessary amount of capital to form a company, as they would get plenty of outside assistance; but it was desirable that a large part of the capital should be subscribed locally, so as to give them a better control. After some discussion of the best means of promoting such a company, a committee was appointed to make inquiries as to the probable number of consumers.

Hackney.—Paragraphs regarding the relations existing between the Hackney Vestry and Mr. F. H. Medhurst, the consulting electrical engineer, have been going the round of the daily press. It will be remembered that the Vestry a few months ago decided to defer its electric lighting and dust destructor proposal until the Shoreditch scheme has been working sufficiently long to judge of the success thereof, and to gauge the probability of success of a somewhat similar scheme at Hackney. Mr. Medhurst was written to accordingly. The latest stage is that Mr. Medhurst claims 2½ per cent. commission on the sum of £80,000, which the combined scheme was estimated at, whether the scheme is carried out or not, as he holds that he was appointed to carry it through. The Electric Light Committee is considering the matter.

Halifax.—The contract for the lighting of the new banking premises for the Halifax and Huddersfield Union Banking Company, Limited, has been placed with Messrs. J. Sunderland and Co.

Hastings.—The Town Council is still grumbling about the unsatisfactory lighting of the "front line." There was a lengthy discussion on the subject the other day.

The Local Government Board has agreed to the Council's proposal to use part of their pumping station in Waterworks Road for electric light works.

Hull.—The Electric Lighting Committee, on 31st ult., considered the application of the North-Eastern Railway Company for current for 700 electric lamps to be installed at the Station Hotel. The engineer recommends that all consumers having their premises wired for at least 100 lamps of 16 C.P., or their equivalent, should have the option of being charged at the ordinary rate of 5½d. per unit, or, as an alternative, of being charged on the Wright rebate indicator system. The question of a site for the new station was also under consideration.

Johannesburg.—Messrs. Siemens & Halske have agreed to present to the Johannesburg Hospital, free of charge, a complete electric light installation. This is equivalent to £2,000.

Liverpool.—The electric light is to be introduced into the Picton reading room.

Nuneaton.—The new Electric Light Company has asked for permission to erect overhead wires.

Newcastle.—The City Lighting Committee which visited Edinburgh on December 7th, has issued its report in regard to the electric lighting of that city. The history of that very successful undertaking, and a description of the plant, is given in the report.

South Shields.—On Saturday last, a Local Government Board inquiry was held at the Town Hall, South Shields, by Major-General H. Darley Crozier, R.E., respecting the application of the Council to borrow a further sum of £7,500 for the extension of the electric light in the borough. The new plant will double the capacity of the station. Mr. Jeckell, electrical engineer, said at present they had 14 arc lights, and 17 more were in course of erection. They had connected 3,679 incandescent lamps besides, and between 600 and 700 additional lamps had been applied for.

St. Helens.—The electrical engineer reports that the supply of electricity to the public was commenced on the 5th inst, and that he has received applications for supplies equal to 340 lamps of 8 C.P. each, in addition to those at the Town Hall, the Gamble Institute, and Mr. Beecham's works, in which the number of lamps to be supplied would be equal respectively to 700, 1,340, and 600 lamps of 8 candle-power each, making a total at the three places of 2,600 lamps.

Uruguay.—The electric light station in Salto, Uruguay, will soon be finished. The machinery was to arrive during December from Germany, and, says a financial contemporary, when this is at work, together with the plant already laid down, the station will have a capacity of 4,000 16-C.P. lamps.

Windsor.—The greater part of the mains which the company intend laying have now been put in position under the pavements of Windsor and Eton.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Bristol.—The Bristol Town Council had quite a battle royal over Mr. George Pearson's resolution to appoint a committee to consider the advisability of the City acquiring the Bristol Tramways. Mr. Pearson argued that the citizens had a right to the benefits of electric traction, and it was not to be supposed for a moment that because of a dispute between a tramway company and the Bristol Corporation that those rights were to be ignored. The company having first declined to negotiate with the Corporation, had thrown up their scheme when the Corporation named certain terms, and therefore he maintained he was taking a perfectly logical step in losing no time in moving his resolution. He was desirous of showing that he, at any rate, had no desire to delay the provision of that quick locomotion which was now becoming a necessity of civilised life. Several speakers took a different view, and Alderman Inskip, who has throughout led the opposition to Mr. Pearson, pointed out that the City had given the company a Parliamentary contract to their lines and a long term of years, and the company was already working part of its system with electricity. That constituted a practical difficulty to Mr. Pearson's proposal to acquire the tramways, seeing there was no likelihood the company would negotiate. Mr. Pearson's resolution was carried, and there were acrimonious passages arising from a suggestion that the committee he named showed a majority already in favour of purchase.

Cardiff-Penarth.—The joint committee to which the electric tramway scheme was relegated by the Cardiff Corporation met again on Monday, and considered the proposals of the syndicate. The Town Clerk read some correspondence which he had received in reference to the proposed electric tramway between Cardiff and Penarth. Messrs. Kincaid, Waller, and Manville, who had been consulted by Mr. L. B. Atkinson, stated that the objections raised by Mr. Harpur could be overcome by suggestions which Mr. Atkinson had submitted. A supplemental report prepared by Mr. Harpur, the borough engineer, was also read. He objected to the suggestions made by Mr. Atkinson for carrying the wires over the Clarence Bridge, and underneath the Taff Vale bridge in Penarth Road, and the Great Western bridge in Clare Road, inasmuch as it would necessitate the construction of the tramway on one side of the road. At Clarence Bridge a conduit system would be preferable. It was suggested that the Penarth Syndicate and the Cardiff Tramways Company could have running powers over the same lines through Corporation Road to the Docks, but the introduction of a second company would create further complications in the management of the highways within the borough. Generally speaking, the ownership of tramways by private companies was not satisfactory, and he considered that by granting the concession asked for the Corporation would be taking a retrograde step. He reminded the committee that when several companies sought permission to provide electric lighting within the borough the Corporation determined to keep the power in their own hands. Of the two proposals—the one for extensions of the present tramway system, and the other for an electric tramway to Penarth, the former would be of greater advantage to the inhabitants of Cardiff, inasmuch as it would accommodate 37,515 in Canton and Riverside, whereas the latter would be a convenience to 13,500, who lived outside the borough. The proposed new route from the Workhouse to the Docks would shorten the time now taken to about half, and if electrically driven to one-third, whereas the electric service to Penarth would take longer than the present tram service. In conclusion, he asked the committee whether they were prepared to hand over their roads to a private syndicate, whose object was to make capital out of them. It was resolved that the report be printed and sent to the members of the Council. The committee, after further consideration, re-affirmed the resolution arrived at on December 4th, which was to refuse assent to the provisional order.

Electric Swing Bridge.—The town bridge at Northwich over the Weaver is shortly to give place to a swing bridge worked by electricity.

Glasgow.—We hear that the Tramway Committee has refused the offer—to which we referred a week or two ago—of Sir William Arrol and Mr. G. Johnson to equip a section of the tramway with motor cars, not electrical. A number of the Committee are stated to be in favour of the overhead electric trolley system. Perhaps the report of the American deputation has had the desired effect?

It is understood that a special meeting of the Tramways Committee will be held in a few days to consider the advisability of laying the line from Springburn to Mitchell Street, three miles in length, with the overhead electric wire system, in accordance with the recommendation of Mr. Young, the general manager.

Great Northern and City Railway.—The Great Northern and City Railway Company, which was incorporated in 1892 with powers to construct a railway from the Canonbury branch of the Great Northern Railway, near Finsbury Park, to the City, has lodged a Bill to obtain an extension of time for two years within which to acquire all the lands necessary for this railway. As the result of this extension, the time for completing the line will not expire before June, 1902. In consequence of the recent failure of this company to issue the necessary capital, the company now seek powers to increase their authorised capital by £60,000, and to issue this amount with their original capital in the form of £900,000 "A" preferred 4 per cent. shares and £900,000 "B" deferred 4 per cent. shares. The shareholders in both these classes are to have equal rights in the division of any surplus revenue, but are not to be entitled to have any deficiency in their dividends for any year paid out of the revenue of any subsequent year. The borrowing powers of the company, which were fixed in 1892 at £500,000, are by this Bill proposed to be increased to £520,000.

Hackney and Motor Cars.—A member of the Hackney Vestry has given notice of motion for the next meeting, suggesting that the General Purposes Committee and the Sanitary Committee jointly consider and report as to the practicability and possible economy of employing for the purposes of the Vestry, carts and vans driven by electric or other automatic motors; also to consider and report as to the advisability of fitting suitable motors to the Vestry's water carts and other vehicles; also as to the purchase of a motor van for experimental purposes for the collection of refuse and scavenging.

Halifax.—The electric tramway question is now occupying the minds of councillors. A committee has been appointed to go into the matter and ascertain the best means of tramway traction for Halifax. The electrical engineer has also been instructed to report on the possibility of propelling tramways with power from the electric light station.

Hartlepool.—The Hartlepools Electric Tramway Company are stated to have decided to extend their lines to the Park and to Seaton Carew.

New York.—A *Financial News* despatch says that the Metropolitan Traction Company has definitely decided to adopt the underground trolley system in vogue at Buda Pesth. The General Electric Company (of the U.S.) will get the contract for adapting the various lines to the new conditions.

Steam Motor Car Trial.—It is stated by the *Times* that Messrs. Thornycroft, of Chiswick, have made a practical test of a motor car, which is not without value. On Wednesday last week they started a road van from Chiswick for Cardiff, carrying down a load of half a ton of asbestos. The distance is about 164 miles, and the van successfully accomplished the journey in 25 working hours, arriving at its destination on Saturday morning without stop for repairs or adjustment. The motive power used was steam.

West Bromwich.—The Highways Committee has decided to recommend the Council to oppose the new Bill which is being promoted by the tramway syndicates, and by which it is proposed to introduce the overhead system of electric traction in the place of the engines now in use. This step is taken to secure a *locus standi* when it comes before Parliament.

TELEGRAPH AND TELEPHONE NOTES.

Cable Companies Dinner.—The third annual dinner of staffs of the cable companies was held at the New Corn Exchange Tavern, Mark Lane, on Friday evening last, Mr. L. T. Obel (Great Northern Company) in the chair, Mr. E. G. Phillips (Commercial Company) in the vice chair. All the principal cable companies were represented, and over 100 guests sat down to almost "every dish that cookmen could divine." During the evening, telegrams of greeting and good wishes were received from many of the telegraph offices of Europe, far and near, including one from the cable telegraphists of Liverpool, who at the same time were holding their fifth annual dinner. After the dinner a very successful smoking concert was held.

Telegraphic Interruptions and Repairs:—

CABLES.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Maranham-Ceará	Dec. 2nd, 1896 ...	...
St. Croix-Trinidad	Nov. 30th, 1896 ...	...
Suakim-Djedda	Dec. 5th, 1896 ...	Jan. 9th, 1897.
Mozambique-Lorenzo Marquez	Dec. 24th, 1896 ...	Jan. 4th, 1897.
Hong Kong-Macao	Jan. 5th, 1897 ...	...
LANDLINES.		
Trans-Continental line beyond Mazol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Salisbury-Umtali	July 11th, 1896 ...	...
Saigon-Bangkok ...	Dec. 30th, 1896 ...	Dec. 31st, 1896.
	Jan. 5th, 1897 ...	Jan. 5th, 1897.

December 5th, 1896.—Katarina-Larissa route working badly.

Coast Communication with Lightships.—The following cutting from the *Daily Mail* of 4th current would go to show that the surmise expressed in the ELECTRICAL REVIEW Leader of December 25th last is not far removed from the truth, and we would commend the matter to the consideration of the Royal Commission on Electrical Communication with Lightships. Is the continuous cable system between the Goodwin light-vessel and Ramsgate abandoned, as well as the diffusion, or induction method, lately tried? Investigation is certainly needed:—"Several times recently lifeboat crews and galleys have had to put off to the Goodwin Sands in response to signal guns from the lightships, only to return after fruitless searches. Last week alarm guns were again heard from the lightships, and the firing was repeated so often, that little doubt was left that some vessel was in distress. The tug *Premier*, which was anchored off the pier, towed the Deal men out very quickly; but after visiting the various lightships, they found that each had been alarmed by the other, and there was no sign of any vessel in distress. The matter seems to call for investigation."

India-Rubber Growing in the West Indies.—The following extract is taken from an interview with Mr. Quintin Hogg published in the *Financial Times* of December 23rd:—"How about India-rubber as an alternative product?" "Well, we tried it in Ceylon, and it was a great failure. It is a difficult tree to grow, and takes some time to establish. The planters will not throw money away in wild speculation of this kind. You might as well talk of establishing oak forests in England to start a new industry with. Tea gave profits in three years to the Ceylon planters. India-rubber would take many before success was assured."

Penzance Telephones.—A telephonic installation has been completed here by the National Telephone Company, and there are already 22 subscribers.

Submarine Telegraphs.—The *Times* of Monday last, treating upon events which have occurred in or concerning the Colonies in 1896, mentions the unfortunate breakdown of the submarine cable occurring at the critical moment of Dr. Jameson's raid under the heading of "Africa." Under "Canada" a reference to the Cable Conference is made, and the *Times* believes its sittings have resulted in bringing the Pacific cable near to completion. "Other Colonies," which are all those excepting Africa, Australia, and Canada, receive little notice, and there is no reference to telegraph matters in the West Indies, &c., although they are questions of great concern to those places. The *Daily Mail* says:—"The decline in the West India trade is, of course, the result of the impoverishment of the sugar planters. The Barbadians and others have been driven to make reciprocal arrangements with the United States for the export of their sugar, &c., in order to maintain an existence at all. It is possible that the trade with Halifax will revive, in view of Imperial assistance to the West Indian planter as an offset to the Continental bounty system. There is no question of the preference of the West Indians for British and Colonial products. They prefer to trade with Canada: they are driven to deal with the States. One great means of accelerating this trade, and of binding the temperate tropic, and sub-tropic colonies together, is within the reach of the Imperial Government. It is the Bermuda cable. Halifax has direct cable connection with Bermuda, second only to it in naval and military importance in North America. Why should not this cable—already laid under Imperial subsidy, chiefly for strategic purposes—be extended to the West Indies? Had such a cable extension been made two years ago, before the Cuban outbreak, it is impossible to realise the advantages which might have accrued to both Halifax and the West Indies. At present all telegraphic communication with the islands is carried through the United States and Cuba at immense cost. The cable rate is 10s. 6d. a word; and even then, owing to the state of affairs in Cuba, unreliable to a degree. One merchant tells me that he spent $70 last week in an attempt to communicate with his agent at Antigua, and his failure cost him hundreds of pounds. At present it looks as if Jamaica, by the excellence of her tobacco, by giving employment to hosts of Cuban refugees, were slowly but surely filching much of the cigar trade of the Queen of the Antilles. In other respects the future of Jamaica is assured. Why need there be any further delay in connecting Kingston with Bermuda, and so on to Halifax? Truly, it were time this question received Imperial attention."

The *Colonies and India* says that owing to a breakdown in the cable, the report of Mr. Rhodes's speech reached London a day late.

Submarine Telephone Cables.—The Central Union Telephone Cable has recently laid 900 feet of 50 pair submarine cable across the Maumee River, at Cherry Street, Toledo, O., in two cables, each 450 feet long. The cable is made up of seven strands of No. 28 wire, American gauge, twisted together. Each of these stranded conductors is insulated 145 inch with okonite. Each pair of conductors is twisted in spirals 3 inches long, laid up with jute, and armoured with No. 6 iron wire galvanised. The cable is buried in the river bed, the laying being done by an expert diver. It is secured, says a trans-Atlantic contemporary, at each bank in such a manner, that if at any time it is hooked and dragged by passing craft, it will tear away from the terminal box, but will be recovered by means of the twisted wire stay rope.

The American Pacific Cable Scheme.—The American Pacific Cable Company have proposed a new contract, by which they are to have two years in which to obtain concessions from the Japanese Government and the Australian colonies relative to the laying of cables from Hawaii to Japan and from Hawaii to Australia. The company offers to purchase $375,000 of the new 4 per cent. Hawaiian Government bonds, and to forfeit $125,000 in case an inter-island cable is not laid within a year. If the desired concessions from either or both Japan and Australia are obtained within two years, the company will forfeit $125,000 in each case if it fails to construct the cable within three years thereafter. On these lines they ask 20 years' exclusive franchise. Acting Minister of Foreign Affairs W. O. S. Smith, on November 16th, says the *Electrical Engineer* of New York, notified John W. Foster, attorney for Col. Z. S. Spalding, that after due and careful consideration on his request for an extension of concessions already granted to Colonel Spalding, the Government has decided that it is not advisable at this time to extend any of the franchises or privileges he may now have regarding the laying of a cable from the United States to Hawaii, so as to include an exclusive franchise for a cable line between Hawaii and Australia or Japan, or both. While the Government regretted that it was unable to comply with the request, the executive wished to express hopes for Colonel Spalding's success in building the line originally proposed between the United States and Hawaii.

The Lion and his Chops.—With reference to the paragraph from the *Colonies and India*, which recently appeared in the ELECTRICAL REVIEW, and in which the desirability of bringing about closer commercial relations between the West Indies and Canada by the laying of a cable from Bermuda to the West Indies was emphasised, the Chicago *Electrical Journal* reprints this note, with the following footnote:—"*Apropos* of the quiet licking of his chops by the British lion as he views Cuba during these fateful days, we commend the above quoted matter to our State Department."

Telegraph Interruptions and Bicycles.—General A. W. Greely, chief signal officer of the U.S. War Department, in his annual report says, according to a New York exchange, that interruption to telegraph communication has been so infrequent during the year as to be practically nil. The most frequent cause of interruption has been maliciousness, through a tendency of lawless individuals to pull down poles, cut wires, or shoot off insulators. The speedy resumption of communication after such occurrences has been due, to a great extent, to the adoption of the bicycle as a means of transportation for repair men in place of the more expensive horse and waggon. The bicycle affords the more rapid as well as more economical method of travel. Frequently breaks in a line have been repaired by the use of the bicycle in less time than would have been consumed in obtaining a horse and vehicle. At some stations in a single year the original value of the bicycle has been saved to the Government.

The Amazon Cable.—The U.S. Consul at Para reports that the Brazilian Government is having a hard time in trying to operate the new cable to Manaos. The cable, costing about $1,000,000, was guaranteed by the company for 30 days. On the 31st day it failed, and no message has been sent over it since last February. It is hoped to have it in working order by the end of the year. Engineers now assert that a cable up the Amazon cannot be made a success on account of the current and many obstructions in the river bed. The cable is of Siemens make, and one of the best ever laid, but the conditions are said to be worse than those encountered even by cables in the busy Hudson River.

Telephone Directory.—The National Telephone Company has issued to its subscribers a Supplement, dated January, 1897, to the Telephone Directory, bringing the list up to date.

The Government and the Telephone Trunk Lines.—At a meeting of the Liverpool Chamber of Commerce last week, it was agreed to forward a memorial to the Postmaster-General with reference to the delay in communication by telephone between London and Liverpool. The Chamber had obtained an expression of opinion from leading commercial firms on the subject, and it had been found that a great many of them had ceased to take any interest in the matter of telephonic communication, as they had discovered it was entirely useless to them in the furtherance of business, and had reverted to the old telegraph service.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—Tenders are at present being invited by the Municipal Authorities of Visé for the electric lighting of the public streets of the town. No date has been fixed for the sending in of tenders but full particulars may be obtained by applying to the Collegè Echevinaè, Visé.

Blackburn.—January 9th. Tenders are invited for the laying of a service of electric fire-alarm communication between the various buildings of the workhouse, for the Guardians. Plan and report showing the requirements of the Guardians may be seen and information with regard thereto obtained upon application to Inspector Simpson at the Borough Fire Station, Clayton Street, Blackburn, by appointment.

Bristol.—January 21st. The Electrical Committee want tenders for five Lancashire boilers for the electric light station.

Edinburgh.—January 28th. The Managers of the Royal Infirmary are inviting tenders for the complete wiring of the Infirmary buildings. Particulars from the treasurer and clerk (Mr. W. S. Caw), or Prof. Kennedy, 17, Victoria Street, S.W.

France.—January 19th. Tenders are being invited by the French Post and Telegraph Authorities in Paris for the supply of two lots of iron pipes 80 mm. internal diameter for pneumatic lines. Tenders to be directed to the Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

France.—January 21st. The French Post and Telegraph Authorities in Paris are inviting tenders for the supply of 103,745 creosoted telegraph poles. Tenders to be sent to the Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

France.—January 31st. Tenders are being invited until January 31st next, for the contract for an installation of electric lighting in the Asile d'Aliénés at Saint Jvon (Seine Inférieure).

Germany.—January 11th. The Prussian State Railway Authorities at Kattowitz are inviting tenders for the supply of a quantity of arc lamp carbons. Particulars for 6d. from, and tenders to be sent to, the Konigliche Eisenbahn Direction, Kattowitz.

Germany.—January 12th. The Breslau Direction of the Prussian State Railways is inviting tenders for the supply of a quantity of porcelain insulators and telegraph wire. Tenders to be sent to the Konigliche Eisenbahn Direction, Gartenstrasse, 106, Breslau.

Halifax.—January 12th. The Corporation want tenders for a 300 kw. slow speed steam alternator.

Hull.—February 1st. The Corporation of Hull is prepared to receive tenders for a lease of the tramways authorised to be constructed by the Tramways Orders Confirmation (No. 1) Act, 1,896.

Jamaica.—April 15th. The Privy Council invites applications for a license for the establishment and working of a system of rapid transit in Kingston and environs. Copies of the Tramways Law, 1895, and of local rules and maps of Kingston and environs may be seen at the offices of the Crown Agents for the Colonies, London.

Portsea.—January 20th. The Portsea (Portsmouth) Island Union is inviting tenders for electric lighting and hot water and engineering work at the new infirmary buildings, Union House, Milton. Particulars of C. W. Bevis, architect, Elm Grove Chambers, Southsea.

St. Pancras.—January 26th. The Vestry wants tenders for supplying and laying earthenware conduits, lead covered armoured cables, and bare copper strip conductors in culverts. Particulars at the Electricity Department Offices, 57, Pratt Street, N.W. See our "Official Notices."

CLOSED.

Monmouth.—At the monthly meeting of the Town Council on Monday, tenders for carrying out certain portions of the scheme for drainage and electric lighting in the borough were accepted as follows:—Contract No. 1 (machinery) and contract No. 2 (electric lighting machinery), Messrs. Siemens Bros., Limited, London, £6,980; Contract No. 3 (for constructing a new system of sewers in the town), Messrs. Johnson, Hereford, £8,005 14s. 4d.

Stafford.—The tender of Messrs. Manlove, Alliott & Co. for alterations to the Town Council's refuse destructor at a cost of £320 has been accepted.

NOTES.

The Electrical Standardising, Testing and Training Institution.—Lord Castletown, of Upper Ossory, and the Board of Control of this Institution, have issued cards of invitation to an Old Students' dinner to be held at the Imperial Institute on the 27th inst.

The Skater and the Footwarmer.—An American skater returned home with cold feet. Whether he was a bachelor or no we are not told, but he took an electric footwarmer to bed with him to warm his understandings. The skater slept, and as he slept he kicked, and the lamp globe having no wire guard could not survive the shock. In consequence, as the current still remained on, the feet of the sleeper became warm beyond endurance, and the bed clothes began to burn. The pleasant dreams of the skater were soon interrupted, and to cut a long story short, he now limps about with much greater understandings of the principles of electricity. The moral of this little tale, which is told by an exchange, is "if you buy electric footwarmers buy proper ones."

The Battle of the Experts.—Our contemporary, the *Railway World*, in its January issue, has an article on the Bristol Corporation and electric traction, from which we extract the following interesting paragraph:—

> Besides the general question of public policy, there is the underlying technical question whether the Council is right in the contention that current can be more cheaply generated where the traction and lighting plant is combined. Mr. Preece, in his report to the Council, supports the opinion that it can. Mr. Parshall differs with him *in toto*, and no less eminent authorities than Lord Kelvin and Dr. John Hopkinson concur with Mr. Parshall, and advise the company not to enter upon such an arrangement. In these circumstances, the company would clearly not be justified in any attempt at compromise, and their withdrawal of the Bill was the only course open to them. As to the arguments set forth by Mr. Preece and Mr. Parshall there have been great differences of opinion among electrical experts, but it is scarcely open to doubt that Mr. Parshall's contention is the correct one as far as Bristol is concerned.

Incandescent Gas v. Electricity.—A leading American central station manager writes to the N.Y. *Electrical Engineer* on this subject. He says:—

> We have had more trouble from Welsbach burners this fall than ever before. It is fair to assume that the majority of our customers are using the Welsbach, and only use incandescent light in the windows. We have to the present time been able to keep up our business regardless of this fact. I am not very much dispirited as to the final result of the Welsbach, as I believe that the character of the light, the heat, &c., are going to drive it out eventually. Still, it is an evidence of the progress which is being made to utilise gas, while the electrical people are, so far as I know, sitting still almost in the spirit that everything has been accomplished. I have repeatedly urged that it is of the most vital importance to electric light people, and the extension of their business, that higher candle-power be produced with the same energy as is now required by 16 candle-power lamps.

The activity of the incandescent gas people in this country requires that electrical men here must also be on the alert.

McDonald "Out-MacDonalded."—*Answers* has somehow or other got hold of the following:

> A vegetable powder has been discovered which, when mixed with water, forms an electric battery, one cell of which is said to be strong enough to run half a dozen incandescent lights. With two cells a power of 110 volts is claimed. The powder is claimed to be made from the roots of a common plant, the name of which is kept secret, awaiting a patent.

Fancy patenting the powder obtained from the roots of a common plant, probably a mere electric lighting plant!

The Extraction of Antimony.—A new method of dealing with the antimony in gold-bearing ores has been devised by a Melbourne man, J. Jones. In its essential principles, the process is as follows:—The powdered ore is treated with hydrochloric acid in a closed vat, provided internally with a steam coil for heating purposes, and with a rotary stirrer actuated from without; the hydrogen sulphide generated is collected in a tank of water placed above the vat. When the acid is saturated with antimony, the solution is run off through an asbestos filtering box to an electrolysing vat, in which the antimony is deposited on suitable cathodes opposed to insoluble anodes; the chlorine produced by electrolysis is conveyed to the hydrogen sulphide tank, where it reacts with the latter substance, forming precipitated sulphur and hydrochloric acid, which may be used to treat a second batch of ore. The electrolysed solution is also returned by means of a pump to the dissolving vat. The ore, freed in this manner from antimony, still retains the whole of the gold, and for further treatment is removed from the vat through a man-hole provided at the bottom.

Electrolysis and Molecular Physics.—The masterly address given by C. L. Mees before the Physics Section of the American Association for the Advancement of Science, contains some most excellent food for reflection, and is full of suggestions. Electrical theories have undergone, during the last 15 years or so, some very important and significant changes, changes which have had a revolutionary tendency in the study of electrolysis, and in the problems appertaining to molecular dynamics. Indeed, to use a useful geological expression, this department, we acknowledge, may be still considered to be in the transitional stage. The various theories propounded as an explanation of electrolytic action by Stahl, Lavoisier, Galvani, Volta, Grothus, and others, have received during the past few years most severe checks, and opinions regarding them are widely divergent. Modern views on electrolysis may, for the present at any rate, be considered to be based upon the experimental work of Hittorf, which was commenced some 48 years ago. The laws of Faraday will ever stand as a constant guide in the conception of electrolytic theories, and it was upon these that the work of Hittorf was carried on, and followed up by Kohlrausch, who first pointed out the general law that the velocity of an ion in very dilute solution is dependent only on the nature of the solution, and not upon the ions with which it is associated; a fact which indicates a radical departure from the old theories, and at the same time justifies the conclusions of Hittorf to the effect that the ions migrate independently of one another. Add to this the experimental proof that the molecular conductivity increases with the dilution, and we have presented the dissociation theory so ably advocated by modern and prominent investigators. It is unnecessary to say that the theory of dissociation has, however, by no means been carried to its completion, several most important problems still remaining to carry out a conclusive demonstration of its correctness. The remarkable experiments of Pfeffer on osmotic pressure, so carefully interpreted by Van't Hoff, clearly shows that similar laws to those which apply to gases apply to solutions, and that the kinetic energy theory may be made to include both. It was by combining the theories of electrolytic dissociation and osmotic pressure that Nernst built up his not generally accepted theory for explaining the E.M.F. of primary cells. Those who disagree with the concepts of this theory take exception to the idea of the existence of a solution pressure for metals similar to a vapour pressure in the case of liquids. Whether or not this conception is finally accepted, the two theories upon which it is based have received quite conclusive proofs of their correctness. The problems in physical chemistry having a special bearing upon electrolytic theories, and which now await solution, are many. Among those which have been pointed out may be mentioned the source of electric charge of the ions; the cause or causes of dissociation; the exact nature of conduction in solids, and whether the same may be explained by electrolytic theories; the determination of the heat absorbed by the passing of salts into solution; the nature of an electric conductivity in gases and the action of ultra-violet light and Röntgen rays on charged surfaces, and their bearing upon electrolytic theories. These are but few of the problems open for investigation, and it is to be hoped that the mathematical work of Willard Gibbs may be carried on to a successful issue. These problems, when solved, will have opened up a vast field in molecular dynamics, and will materially aid in clearing up the somewhat vague concepts which at present prevail.

The Electrolysis of Water.—This subject has ever been one possessing a certain fascination for research, and it seems that we have by no means received the last word upon it. There are likely to be very many more investigations undertaken before we can consider that our knowledge of the electrolysis of water is final. Obviously the subject is one of paramount importance, inasmuch as in all commercial electrolysis, water, "the universal solvent," as it used to be called, must necessarily play a very large part. The subject of electrolysis is still in its infancy, and an inspection of the number of patents which have been taken out during the last five years, relating to it, of itself constitutes very strong facts in favour of the rate at which it is growing, and of its strong vitality. We cannot, however, but notice a paper by A. P. Sokoloff, in the *Annalen der Physik und Chemie* (1896, Vol. 58, p. 209), on this subject, which is important, in as much as some of the previously accepted views attributed to Helmholtz are somewhat contradicted. According to Helmholtz, the E.M.F. required for the electrolysis of water depends directly on the densities of the hydrogen and oxygen at the electrodes; the smaller these densities, the weaker will be the E.M.F. required, and in a liquid from which all gas has been completely removed, the value must sink to zero. Helmholtz has further deduced an expression connecting the E.M.F. of polarisation, A, for any pressures, p_h and p_o, of the hydrogen and oxygen, with the E.M.F. when the pressure, p_a, is the atmospheric, and determined the value of this last quantity, A_a, as being 1,783 volts. A direct proof that the decomposition of water can be accomplished with any E.M.F., however small, has not yet been given, nor can Helmholtz's determination of A_a be regarded as final; the author has, therefore, submitted these points to further experimental investigation. In order to obtain proof of electrolysis when the E.M.F. is very small, a voltameter was arranged, which contained two platinum plates as electrodes, and in the immediate neighbourhood of each plate an insulated platinum point. When a current is passed, the electrodes become polarised by gas layers of definite density, but as these gases are electrically neutral, and therefore quite free, they diffuse through the liquid, and must, in a short time, reach the platinum points and polarise these just as each electrode was originally polarised. This polarisation can then be easily detected by means of a sensitive electrometer. The experiments quoted in the paper, in which this arrangement was employed, show that electrolysis can be produced by any E.M.F., however small. In contradiction to Helmholtz, the author finds that an E.M.F. of 1 volt suffices to produce gas of measureable pressure by the decomposition of water. Thus, in one experiment, which lasted 16 months, a calomel cell (1·072 volt) produced gas of 2·53 mm. pressure, and from the continual increase in the pressure, this seems to be even far below the limiting value. From the results, it appears that difficulties are encountered in producing invisible electrolysis with a small E.M.F., similar to those met with when visible electrolysis is effected. Forces are active on the surfaces of the electrodes which restrain the gases from freely diffusing through the liquid, and bring about absorption of the gases by platinum and other metals. The forces here spoken of introduce difficulties in the determination of A_a from the results of experiments on visible electrolysis. Determinations which the author has made at low pressures give a value for A_a of 0·745 volt, which is very much smaller than that given by Helmholtz.

Separating and Refining Metals by Electrolysis.—In the July number of the *Moniteur Scientifique* there is a paper by D. Tommasi, whose work we have often had occasion to notice in these pages. In this paper is described a new process, by means of which it is possible to separate and refine metals by electrolysis. In order to give some idea of what this process is, the following brief abstract may suffice:—The anodes are either cast plates or granulated material, resting in direct contact with the positive leads. The cathode is a vertical disc, capable of rotation about its horizontal axis. Only the lower portion is immersed in the electrolyte, and the upper part is passed during rotation between scrapers that effect the removal of any spongy deposit, transferring it to channels, by which it is conveyed to a convenient receptacle. The disc is constructed in replaceable sectors, when a reguline deposit is to be obtained, and the sectors are one by one removed mechanically as they attain sufficient thickness, and are plunged beneath a fluid bath of the metal under treatment until the deposit has been melted away, and the sector is ready for use again. A solid disc is preferred for spongy deposits. The advantages of this arrangement are that polarisation is prevented by the rotation of the cathode, and by the action of the scrapers, and the liquid is sufficiently agitated to prevent separation into layers of different density, whilst spongy deposits are removed as fast as they are produced, thus preventing oxidation by the liquid, and the occurrence of local action. At the same time the electrodes may be allowed to approach more closely, owing to the impossibility of short-circuiting through irregularity of deposit, and the resistance of the bath is therefore sensibly diminished. The original paper appeared in the *Moniteur Scientifique*, July, 1896, Vol. x., p. 507.

The Electrical Purification of Beet Root Juice.—Regularly there appears in Dingler's *Politechnishes Journal* quarterly reports respecting the progress that has been made in the scientific department of the sugar industry. We have before us a number in which there is an article reviewing this subject for the first quarter of 1896, and it must not be overlooked, inasmuch as it contains some information regarding the methods of refining beet root juice or sugar cane juice by means of electrolysis. When it was proposed a few years ago to purify the juice of the beet root or sugar cane electrically, a considerable amount of opposition was raised, and Schollmayer's method was, perhaps, more criticised than any. It is not generally known, however, to what extent this method is employed, especially in Germany. According to Juraux, Gallois, and Dupont (*Gazeta Zukrownicza*, 1895, No. 16, through *Zeits. für Zuckerind, in Bohmen*, 1896, No. 20, p. 252), lime or baryta is added to the juice from the beet root or sugar cane until there is a slight alkaline reaction. It is heated from 85°—90° C., filtered, and electrolysed in two series of vessels; the first being on a higher level, so that the juice can flow into the second. The first vessel is divided by two porous porcelain plates into three compartments; the middle one containing the defecated juice, and the two outer, water. The cathode, either of manganese or aluminium oxide, is lowered into the juice, whilst the anodes, prepared of carbon, iron, or other materials insoluble in alkali, are placed in the water. Acids are liberated by the electrolysis from the cathode, and combine with the same; the alkali diffuses through the porcelain plates into the water. The juice then flows into the second vessel, where complete purification is effected by means of lead electrodes. When the electrolysis is finished, the juice is run off and the precipitated organic compounds and lead salts are removed by filtration. Should the juice still contain traces of lead, they can be removed by rendering slightly acid with phosphoric acid, the excess of the latter being adjusted by lime. Little is known of this process, which, if generally employed, would revolutionise the purification of juice. One refinery, however, which has employed this or a similar method (*Neue Zeitschrift für Rubenzuckerindustrie*, 1895, No. 36, p. 19), finds that the lead anodes become covered with an insoluble precipitate, consisting for the most part of lead oxide, with which, apparently, the organic acids are too weak to combine, and the working is, therefore, hindered. Of course, the subject of electrical purification of the juices from which crystallised sugar is made is practically in its infancy, and we consider that it is something to have achieved so much in so short a time. It is to be hoped that those who are endeavouring to exploit the matter will not allow themselves to be disheartened by adverse criticisms, but that such criticism as they meet with shall have the effect of encouraging them to improve their processes, and to eliminate from them everything which is open to question. If our readers are interested in consulting the original paper, they will find it in *Dingler's Politechniches Journal*, 1896, Vol. 300, p. 258.

Electro-Therapeutics in America.—At the annual meeting of the American Electro-Therapeutic Association recently held in Boston, Dr. Robert Newman, the president, took, as a subject of his opening address, the want of education in electro-therapeutics in medical colleges. He expressed it as his belief that the principal cause for the scepticism felt toward the application of electricity in medicine was due to the fact that the medical colleges throughout the country had failed in their duties as instructors, and that the mass of general practitioners were as a rule deficient in knowledge of electro-therapeutics, and, also, of the elements of physics. He had found that only a very small per cent. of the medical colleges had a course in electro-therapeutics, and that in many of them it was but superficial in its nature. Referring to the ends accomplished by the association, the president said that:—(1) It has improved its members, educated the profession and the public in, and generally improved electro-therapeutics. (2) It has made electro-therapeutics a specialty, and disclosed the difference between the educated physicians and the pretentious charlatans. (3) It has made friends with the physicist, the electrical engineer, the electrical press, and harmonised them all, as will be evidenced by lectures from eminent professors, *not* doctors. (4) It has induced progress in electrical science through the comparison of the results of the labours and investigations of its standing committees. (5) It has caused improvement of electrical instruments and appliances by bringing them to a uniform standard. (6) It has awakened rivalry in establishing clinics and chairs in colleges for better instruction in electro-therapeutics. (7) It has recognition in Europe. (8) It has encouraged manufactures of instruments, producing as a result the high tension batteries, perfect static machines, sinusoidal current, etc. (9) It has brought about progress in electrical literature, new books, new journals. (10) It has produced a strong society, in which will soon be combined, for advancement, social and scientific, the ripest scientists. All this is very satisfactory, and we heartily wish the American Electro-therapeutic Association every success. During the course of the meeting, which occupied several days, reports were presented by the Committee on induction coils, alternators, meters, generators, and controllers. Amongst the papers read was one by J. J. Cabot on "Accidents and Risks in Using Electricity Generated at Central Stations and Transmitted over Underground or Overhead Wires to Operators in Electro-therapy." The author considered the fuses in general use to be entirely untrustworthy, and that rheostats on commercial circuits are a delusion and dangerous as now employed. He considered that they should be ironclad. Currents from commercial circuits should be used for cautery purposes only. The paper was rather severely handled by the other doctors in the discussion, and the general opinion appeared to be that the author was raising a "scare-head." All were agreed, however, that doctors should take a thorough course in electricity. Other papers were read by Dr. Einhorn on "The Static Current in the Post Apoplectic State;" by Professor Puffer on "Electrical Principles generally used in Electrical Treatment;" by Professor Dolbear on "The Relation of Physics to Physiology;" by Dr. Watson on "Electro-therapy in the Treatment of the Nervous;" by Dr. Bishop on "The Use of the Static Cage;" by Dr. Davis on "The Rôle of Electricity in the Treatment of Uric Acid Diathesis;" by Dr. Wallis on "The Treatment of Strictures by Electrolysis *versus* any other Treatment;" by Dr. Bishop on "The Newman Method of Urethral Electrolysis;" by Dr. Herdman on "The Application of Electricity to Surgery," etc., etc. From this selection from the programme it will be seen that the Association covered a very wide field, and we may congratulate it upon having done useful work. America is certainly leading the way in this branch of applied electricity.

Official Photometry.—Ordinary people are so prone to believe that "official instructions" are infallible, that the results obtained from them are usually accepted without comment. Of course, a little reflection will at once lead to the conviction that no instructions of any kind are infallible, and official instructions are as likely to err as are any others. It seems, from a paper by L. T. Wright in the *Journal for Gas Lighting* (Vol. 67, 1896, page 1213), that there is a very considerable source of error in the methods of photometry adopted by the London Gas Referees. The operator is told to burn the gas at 5 feet per hour, and then multiply the photometric reading obtained by the factor of correction due to temperature and pressure. Wright maintains, however, that the number so obtained is not necessarily the same as, and may often vary by 3 to 4 per cent. from, the result obtained by actually burning 5 feet normal, this latter being evidently intended by the Act of Parliament. The error in the present method is due to the differences of efficiency of the argand burner when consuming different quantities of gas. Wright considers that more constant and reliable results would be obtained if the volume of gas at the conditions of temperature and pressure of the test which would equal 5 cubic feet normal, were first calculated, and then the consumption regulated to that rate. More reliable results than at present would be obtained if the gas were always consumed at a rate sufficient for the flame to just fill the chimney, and then correction for quantity were made; or if, with any rate, the admission of air to the argand were regulated, as by the latter means the maximum efficiency of the gas may also be obtained. It is very remarkable that the instructions of so absolute an authority as the London Gas Referees should be thus making an error. So much capital has been made out of official comparisons, that we are glad to see that this is liable to a heavy discount.

The Economical Point of Compression.—We think that a good deal of mathematical skill is expended upon steam engine working that cannot possibly be beneficially carried into practice. One of the subjects so dealt with, is that of compression, a subject taken up by Mr. Eddy in the *Electrical World*. Given the cylinder volume, clearance volume, pressure of admission, of exhaust, and the ratio of exhaustion, Prof. Webb has shown graphically how the compression curve may be found to suit a given expansion curve, &c. He produces the expansion curve until it intersects the line of exhaust pressure, and finds the area thus added to the card. By a line parallel with the atmosphere, he cuts off from the top of the diagram an area equal to the above addition. Where this horizontal line cuts the vertical clearance line will be a point in the compression curve. Mr. Eddy finds analytically that the compression ratio thus found will exceed the given exhaust ratio if exhaustion is incomplete, and he concludes the best ratio of compression to lie between the expansion ratio and the ideal case of complete compression. Taking the converse operation of finding the best expansion ratio, the previous data and the compression being given, he prolongs the compression curve to cut the admission pressure line, and measures the area thus added to the diagram, and cuts an equal area of the diagram at the bottom by a horizontal line, and the intersection of this with vertical line expressing total cylinder volume and clearance, will be a point in the best curve of expansion, and the expansion ratio will be greater than the compression ratio, as may be analytically shown, which proves that the method cannot be correct, for if we proceed to find alternately the best ratios of expansion or compression from the immediate past result, we shall have a never-ending expanding series. Of course, this arises from the practical fact that we are not dealing with the theoretically best complete compression or expansion. Mr. Eddy states that the best adjustment is when the ratios of compression and expansion are equal, under which conditions more work is performed by a given volume of steam admitted than when either of the above methods are used. The question in practice is considerably more complex, and we venture to think that the compression curve is very frequently best fixed by considerations of easy running. Many of our readers must know of cases where shock on the dead points, due to abnormally heavy reciprocating parts, has been completely cured by a little extra compression, and until steam engines are built to exact weights and speeds, the exact apportioning of the indicator card will continue to rest with the skill of the engineer.

Electrolytic Bleaching Solutions.—At the recent meeting of the German Electro-Chemical Society, held at Stuttgart, an apparatus designed for the electrolysis of salt solutions, by Kellner-Hallein, was described and discussed. This is an exceedingly important piece of plant, inasmuch as it is specially designed to meet the two requirements necessary for the successful commercial introduction of electrolytic bleaching solutions. These requirements are that the plant used in the production of these two solutions shall be capable of being worked by currents of the potential ordinarily supplied from central stations, thus obviating the necessity of special dynamos; and secondly, that the cost of installation shall be low. Dr. Kellner employs a single ebonite tank, in which as many bi-polar electrodes are placed in series as the working potential will allow of. These electrodes are made of plates of ebonite, provided with brush-like projections of platinum, which arrangement allows of the use of a high current density for a small weight of plate, and the brushes of the first and last electrodes are connected to the conductors supplying the current. The brine is admitted to the tank from below, and passing between the electrodes, it leaves by two channels in the upper part of the tank, and after being cooled, is returned to the vessel. The circulation is regulated so that the amount of active chlorine formed on the passage of the solution through the apparatus is 0·05 per cent., and the process is continued until the amount reaches 1 per cent. This information is derived from *Dingler's Politechnisches Journal*, 301 (10), p. 234. Kellner has also recently worked out some other improvements in electrolytical manufacture of bleaching liquids, these improvements being designed to bring about the requisite cooling. By means of a pump, an 8 to 10 per cent. solution of sodium chloride is passed through the electrolytic vessel, so that 0·05 per cent. of chlorine is formed during each passage of the electrolyte through the apparatus. The electrolyte is passed into a vessel, where it is cooled in any convenient manner, and thence is returned to the decomposing cell, and so on, until the requisite concentration is reached, say, 1·5 per cent. of chlorine, 15 grms. per litre. The pipe connected with the cooling vessel is now closed, and the solution is passed by means of another pipe into the bleaching vessel, or by a suitable modification of the plant, the action is made continuous, fresh salt solution passing into the decomposing cell as the bleaching solution is drawn off.

The Electrical Conductivity of Cement and Concrete.—Electrical engineers, especially those engaged in railways and similar works, would do well to study a recent paper by Dr. Lindeck, in which he describes some experiments which he has been conducting in order to determine the electrical conductivity of cement and concrete of various kinds. He finds that the resistance per cubic foot of pure cement blocks, when dry, is about 144 ohms, and that this falls as low as 43 ohms after immersion for about 24 hours in water, whilst it rises to 820 ohms after being exposed to a heat of 212° F. The admixture of sand or gravel with the cement increases its electrical resistance. In cases where blocks were made with one part of cement to seven parts of gravel, their resistance when dry amounted to about 18,000 ohms, when wet to 72 ohms, and after exposure at 212° F. the resistance rose to about 2,000,000 ohms. If the highest results obtained for air-tight concrete be taken at about 1,670 ohms per cubic foot, an insulation resistance of about $\frac{1}{2}$ ohm per mile is obtained. These considerations become important when adopting the German practice of laying the rails of electrical railways in concrete. From experiments made with what is called asphalte concrete, it appears that the current range is very trifling, and if ordinary cement is used, it is only necessary to lay a thin layer of the asphalte concrete over it. The cost is then not excessive. Asphalte concrete consists of 50 per cent. of broken stone, 20 per cent. of coarse gravel, free from loam and sand, 12 per cent. of asphalte, 8 per cent. of coal tar pitch, and 10 per cent. of coal tar. The original paper appeared in the *Electroteck. Zeits.*, 1896, p. 180.

Acetylene as an Illuminating Agent.—This gas has not caught on very firmly yet in this country; though as we have had occasion to remark before, it is being extensively tried abroad, especially in France and Switzerland, where there have been *numerous explosions* and great *loss of life*. The italics tell their own story. In the *Comptes Rendus* G. Trouvé (*vide C. R.*, cxxii., pp. 1338—1342) describes portable lamps similar in outward appearance to paraffin lamps in which acetylene is generated by the action of water on calcium carbide. Provision is made for drying the gas, and the burner is arranged in a position of greater relative safety with regard to the generator. Where a large supply of the gas is needed, the generators may be attached to a gas-holder of the ordinary form. Two such holders are used, the gas in one being cooled and dried, whilst the other is being emptied or filled as the case may be. Trouvé appears to attach great importance to the proper cooling and drying of the gas before it is burnt; but, as far as we can discern, the risk attached to these acetylene lamps is even greater than that which damns the cheapest and worst form of paraffin lamp made in Bohemia. "Alas! Regardless of their doom the little victims play!"

The Electrolytic Reduction of Benzaldehyde.—Electrolytic processes continue to make their way into the regions of organic chemistry. In the *Chemiker Centralblatt*, 1896, i., p. 101, there is a paper by H. Kauffmann on "The Electrolytic Reduction of Benzaldehyde." He finds that when a solution of benzaldehyde in potassium hydrosulphite solution is electrolysed with a current of 0·8 ampere and 6—7 volts, using a platinum electrode of 130 sq cm. area, hydrobenzoin and isohydrobenzoin are formed. Thus electrolysis puts a new weapon into the hands of the research chemist. The same products we find are formed when the aldehyde is simply covered with a little aqueous soda and then electrolysed, whereas in the presence of sulphuric acid nothing but a tarry mass is formed.

A Scientific Munchausen.—In Alcade, U.S.A., there exists an association known as the Astral Camera Club, which appears to have been formed in order to investigate scientific problems by means of photography. The other day they undertook to visualise a mere thought, and record it upon a sensitive plate. So seven of its most enthusiastic members solemnly sat down and began to think of a cat in a dark chamber which served as a sort of camera. Their success was marked, the imaginary conception was visualised. and the picture of a misty group of seven cats was the result. This picture was printed in the current issue of the *Popular Science Monthly*. Mr. David Starr Jordan, President of the Stanford University, describes the picture as follows:—"As might be expected in a first attempt, there is a lack of co-ordination of the parts. Mr. Gridley, the schoolmaster, had planned his cat on a large scale—a huge cat face, with gray, radiant whiskers, looking directly at the beholder. Most of the others thought of the cat in lateral view or profile. These variant and vagrant individual impressions naturally appeared on the camera before the ether waves were co-ordinated, and the reflex influences came back from all to one, regulating and co-ordinating the thought of the cat. Thus these preliminary impressions are recorded as ghost pictures in various places about the plate, before the ultimate composite view was achieved. The delay in this regard has darkened the centre picture, interfering a little with its perfection of definition. This darkening would probably appear in other experiments on account of the long exposure (16 minutes) thought necessary for a picture of this kind, in which odic magnetism is made to take the place of light." This is conclusively abstruse, but the closing sentence of the paper gives the credulous reader a sad awakening:—"Meanwhile, the cat of Mr. Thompson, the janitor, who alone could answer this question, lay in the darkness under the warm stove, and purred softly." And this is the truth, the only truth, in the article. The photograph was made up by Prof. Sanford (one of President Jordan's faculty) of seven composite views of the College janitor's cat, and for the express purpose of assisting in this hoax upon the innocent public. President Jordon is said to be now away in Alaska hiding from the consequences of his deed.

Note on the Theory of Clausius.—In a recent issue of the *Physical Review*, Prof. Buckingham gives a demonstration of what is usually referred to as the "Second Law of Thermo-dynamics," for cases not considered in Clausius's original proof, and usually treated very briefly by his followers. The cases considered are: (1) Systems whose states is defined by only one co-ordinate besides the temperature, but where the work done is not necessarily confined to overcoming pressure. The co-ordinate used to define the state may be of the most general type, *e.g.*, quantity of electricity, as used by Helmholtz. (2) Systems whose state is defined by more than two co-ordinates. An example of such a case would be an electrolytic cell in which the effect of pressure is not negligible. Prof. Buckingham's article gives an interesting discussion of the graphical, as well as the analytical, treatment of such cases. The article is one which will do good, for the subject is one which must be presented in many different forms, as well as with great clearness, if our text books are to be freed from the hazy and unsound treatment of thermo-dynamics with which they now abound.

A Good Contract for Elmore Copper Tubes.—We hear that the German Government has given Elmore's German and Austro-Hungarian Metal Company the contract for the supply of the whole of the copper tube requirements of the Navy for the next three years.

The Pacific Cable Scheme Approved. — Yesterday's *Daily Chronicle* contained an article a column in length on the Pacific cable scheme, in which it was stated that the Conference has reported in favour of the speedy completion of the trans-Pacific cable from Vancouver to Australia. The report will be sent to the various Governments interested, and it is hoped that the matter may be before Parliament during the forthcoming session.

The Northern Society of Electrical Engineers.—At the meeting to be held at Manchester on Monday, January 11th, 1897, at 8 p.m., Mr. C. M. Dorman, the President for the ensuing year, will deliver his presidential address.

The Production of Colouring Matters by Means of Electrolysis.—One of the most remarkable firms in Germany is the Badische Anilin und Soda Fabrik of Ludwigshafen. From this firm probably emanate more new colouring matters than from any other in the world, and the reason is not far to seek. We believe that nearly 100 skilful chemists are permanently retained for the purpose of working out new processes, and generally carrying on research work. The Germans deserve to succeed, considering that they bring so much science into all their trade operations. We have several times called attention to the possibility of producing dyes and other colouring matters by the aid of electricity, and several useful processes have been worked out, and are now being exploited. Considering what a part chemistry plays in the dyeing industry, and what a number of skilful chemists are engaged by the Badische Anilin und Soda Fabrik, it is all the more interesting to us to notice that this firm is now producing some new yellow mordant-dyeing colouring matters by the aid of electricity. According to the electrolytic process, 10 kilos. of the dihydroxybenzoic acid, dissolved in 40 kilos. of 63 per cent. sulphuric acid, are placed in the electrolytic cell containing the positive electrode. The negative electrode, separated by a suitable diaphragm, is immersed in sulphuric acid. An electric current of 20 amperes per sq. dec. of anode surface, at about 8 volts, is passed through the solution, which is kept constantly agitated, and at about 25° C. When the reaction is complete, the melt is poured into water and worked up by chemical methods. The resulting products give strong, fast yellow shades on wool mordanted with chrome or alumina. Now that this important German firm which we have been speaking about is seriously giving its attention to the production of colouring matters by the aid of electrolysis, we expect this branch of the industry to obtain a great impetus. Another electrolytic process for producing cotton dyes, which is now being exploited by the above firm, should also be noticed. In the manufacture of Congo red, benzene-azo-naphthionic acid used to be oxidised in sulphuric acid solution by manganese peroxide. They now, however, carry out this oxidation by means of an electric current, the following details being given:—A solution of about 50 kilos. of o-toluidine-azo-naphthionic acid (sodium salt) in 750 kilos. of 94 per cent. sulphuric acid, is placed in a porous cell containing the positive electrode of platinum or other suitable material. The porous cell stands in another vessel containing concentrated sulphuric acid and the negative electrode. A current of about 4 amperes per sq. dec. at 5-6 volts is then passed through the cell, until no further change of mono- to disazo-dyestuff takes place. The solution is then poured on to ice, filtered, washed, and converted into the sodium salt.

The Electrolytic Estimation of Mercury.—The persistency with which E. F. Smith and D. L. Wallace have for some years now been following up their ideas relating to the electrolytic estimation and separation of the metals, is quite remarkable, and their efforts have been rewarded, inasmuch as they have succeeded in getting their views accepted by leading chemists, who are grateful to them for having supplied them with a means for determining work which has hitherto been done less expeditiously. Their researches, also, have had a distinct influence upon the electric treatment of metals generally for common purposes. A notice of their latest work appears in the *Journal* of the American Chemical Society (1896, xviii., p. 169). The determination of mercury in cinnabar, by electrolysis of a cyanide solution, is rather a lengthy process, owing to the necessity of first dissolving the mineral in acid, the excess of which has afterwards to be removed. The authors have therefore tested the method first proposed by Smith, and which consists in electrolytically precipitating the mercury from its solution in an alkaline sulphide.

Dissociation Spectra of Fused Salts.—In the *Comptes Rendus*, 1896, cxxii., p. 1411, there is a paper by Arnaud de Gramont on the dissociation spectra of fused salts of the alkali metals. It seems that salts of these metals offer special advantages in the study of line spectra of the non-metals by the action of a highly condensed spark on the fused salt, because of the comparative simplicity of the spectrum of the metal. In the case of these salts, the spectrum with a highly condensed spark differs considerably from that obtained with the spark and the metal itself, or with the fused salt and a non-condensed spark. The carbonates, though dissociated with difficulty, give the spectra of their metals in the simplest form, and no lines of carbon are observed. Fluorides also show relatively little tendency to dissociate, but other salts, such as the chlorides, bromides, and iodides, decompose readily. In the original paper a list of data for sodium, potassium, and lithium salts is given.

Electric Omnibus.—An electric omnibus failed in Queen Victoria Street last Saturday. After 15 minutes rest for repairs, it proceeded on its journey.

Lamp Filaments.—A recent consular report gives some interesting figures on the manufacture of incandescent lamp filaments in Paris. It is stated, says our New York namesake, that filament for 20 C.P. lamps is worth $8,000 a pound, and for 30 C.P. lamps, $12,000 a pound. The filaments for lamps of three candles are so light, that it would require nearly 1,500,000 of them to weigh a pound. As the length of each of them is 10 centimetres, their total length would be 187 miles.

The Electro-Chemical Production of Metallic Sulphides.—In the *Chemical News* for October 16th, there is a translation of a paper recently appearing in the *Zeitschrift für Anorganische Chemie*, 12, p. 442, by Richard Lorenz, describing the general method for the electro-chemical production of metallic sulphides. The author claims that just as the electro-chemical method of preparing the hydroxides of the metals offers advantages over a chemical method, so does the electro-chemical method of preparing sulphides. By the chemical method we have to depend upon the acid, neutral or alkaline character of the solution; by the electro-chemical method we can precipitate any metallic sulphide from a neutral solution if only it is insoluble in water, without the use of sulphuretted hydrogen or a metallic sulphide. A cathode of rod-shaped copper sulphide is selected, and an anode of that metal whose sulphide is to be obtained. The copper sulphide is enfolded in a piece of silk, as there ensues a dissipation of the electrode during electrolysis. As electrolyte there is used an alkaline chloride, nitrate or sulphate. The following experiments may be performed:—Copper as anode, with a cathode of copper sulphide, yields a black precipitate of copper sulphide in a solution of potassium nitrate or chloride. In the same manner, silver yields in a solution of potassium nitrate a black deposit of cadmium sulphide. Tin, in opposition to its electro-chemical precipitation as hydroxide, yields here always the sulphide. Lead, if precipitated from a solution of potassium nitrate, forms black-lead sulphide. Iron yields, in a solution of potassium chloride, a black precipitate of ferrous sulphide. Nickel as anode in a solution of potassium chloride, with a cathode of copper sulphide, yields a black deposit of sulphide. As a matter of course, this reaction may be applied to the production of various other sulphides, and will be capable of manifold extensions. In particular, the behaviour of other sulphides as cathodes will have to be considered. The development of the principle here laid down will be important as regards the electrolytic precipitation of metallic sulphides from aqueous solutions on the application of a sulphide as cathode if it proves possible to fix the ions which appear at the anode. We might thus arrive at an electrolytic method of superseding in the chemical laboratory the nuisance of hydrogen sulphide.

The late Mr. Tyler's Will.—The value of the personal estate of Mr. William James Tyler, the late secretary of the India-Rubber, Gutta-Percha and Telegraph Works Company, has been sworn at £11,798 0s. 3d. gross, and £6,830 16s. 1d. net.

The Institution of Electrical Engineers.—On Thursday next, January 14th, 1897, at 8.0 p.m., the Inaugural Address will be delivered by the President, Sir Henry Mance, C.I.E., M.I.C.E.

Consumption of Current in Paris, London and Berlin.—In Paris there are at present seven electric lighting undertakings, of which one is under municipal control. In London there are 13, of which three are the property of the parish authorities. In Paris the average selling price of the kilowatt-hour is about 11½d.; in London it is about half that price. In October last year the number of lamps connected up in Paris was 545,914 (including 7,448 arc lamps); in London, at the end of the previous year, 1,178,000. In Paris, besides electric lamps, there are 220 electrically driven lifts, and the total energy supplied to motors is nearly 2,000 H.P. The consumption of electric energy in 1895 was: in Paris 8,107,253 kilowatt-hours; in London, exclusive of the City, about 9,553,105 units. In Berlin there are, on the network of the Berliner Electricitätswerke alone, 166,192 glow lamps, 8,216 arc lamps, 1,347 electromotors developing 4,813 H.P., and 292 other appliances. The consumption of energy amounted to 9,770,800 kilowatt-hours, and the dividend of the company to 13 per cent. How do the dividends in Paris and London compare with this?

Report of the Chief of the Bureau of Steam Engineering of the United States.—If we are to judge from this report, the Navy of the United States is undermanned, much as our own Navy, and the Engineer-in-Chief, Mr. Geo. W. Melville, takes care to say so. Our American friends are trying the water-tube boiler in their Navy, but in a much more careful and judicious manner than has been the case here. The Americans have applied them to a couple of torpedo boats, and to one-half of the power of the *Chicago*. The whole report only runs to 17 pages. A summary of tests on five ships is given. We note that the *Brooklyn* developed 18,248 I.H.P. from her main engines, and ran at 21·91 knots, developing 18·05 H.P. per square foot of grate surface.

The Conductivity of Mixtures of Electrolytes.—An important contribution has recently been made to our knowledge of this subject by Douglas McIntosh, who in the *Philosophical Magazine* for 1896 (5) xli., p. 510, discusses the calculation of the conductivity of mixtures of electrolytes having a common ion. He seems to have developed a method of calculating, from observations of a number of simple solutions of two electrolytes having a common ion, the conductivity of a solution containing both electrolytes, the assumption being made that the ionic velocities of the constituent electrolytes are not changed by the mixing. To test the accuracy of the method, the author has examined mixtures of sodium and potassium chloride solutions, and of solutions of sodium and hydrogen chloride. In the case of mixtures of sodium and potassium chlorides, the differences between the calculated and the observed values increase rapidly as the constituent solutions become more and more nearly saturated, reaching 6·4 per cent. in the case of practically saturated solutions. In the weaker solutions of sodium and hydrogen chloride, the differences between the calculated and observed values are evidently due to accidental errors; in the stronger solutions, the differences become more marked and irregular in magnitude. The results show that in the case of two electrolytes with a common ion which differ so markedly in ionic velocity from one another as sodium chloride and hydrogen chloride, the dissociation theory enables us to calculate the conductivity of solutions containing both, within the limits of experimental error, up to a mean concentration of about 1 gram.-mol. per litre, and that in the case of solutions of greater mean concentration the calculated value is greater than the observed.

Electric Lighting in European Cities.—The capacity of the electric lighting installations of some of the leading European cities, when reckoned in 8-candle incandescent lamps, is as follows:—London, 1,300,000 lamps; Paris, 500,000 lamps; Manchester, 92,000 lamps; Glasgow, 70,000 lamps; Liverpool, 54,000 lamps; Edinburgh, 43,000 lamps. Of the total capital invested in electric lighting installations, more than one-half falls to London.

A New Rendering.—The *Electrical Journal*, of Chicago, recently referred to the memorial being proposed to Sir John *Render*. "The idea," it adds, "is to exaggerate the part played by the Englishman at the expense of Cyrus Field"!!

NEW COMPANIES REGISTERED.

Nuneaton Electrical Company, Limited (50,699).—Registered December 30th, capital £10,000, in £1 shares, to form centres in Nuneaton, or elsewhere, at which electric power may be generated, accumulated, or conveyed, to enter into contracts for the supply of electric light or force, and to manufacture, sell, and deal in lightning conductors, electrical generators or accumulators, lamps, fittings, engines, turbines, &c. The subscribers are: R. Stanley, Manor Court, Nuneaton, J.P., 20 shares; W. T. Bates, Coton Road, Nuneaton, miller, 20 shares; W. J. Yoxall, 130, Abbey Street, Nuneaton, confectioner, 20 shares; G. Beck, The Poplars, Stockingford, engineer, 25 shares; W. J. Proctors, Clarence Street, Nuneaton, electrical engineer, 10 shares; T. Norton, 120, Abbey Street, Nuneaton, confectioner, 25 shares; G. Wilson, 129, Abbey Street, Nuneaton, ironmonger, 25 shares. The number of directors not to be less than four, nor more than 10. The first are R. Stanley, E. Brown, J. F. Johnson, T. P. Garratt, W. T. Bates, and G. Wileson; qualification, 25 shares, or £100 stock; remuneration as fixed by the company. Registered by C. T. Twist, 5, Bedford Row, W.C.

Practical Primary Electric Battery Syndicate, Limited (50,745).—Registered January 2nd with a capital of £8,000, in £10 shares, to adopt agreements with S. W. Maquay, F. A. Donnison, and Berlyn, Evans & Co., and to manufacture, sell and deal in primary and secondary electric batteries, electric and other lamps, electric motors, and all machinery, implements, utensils, apparatus and appliances used in connection with the same. The subscribers are:—E. Wendover, Eversleigh, Globe Avenue, Enfield, gentleman, 10 shares; P. E. Vanderpump, 5, Philpot Lane, E.C., solicitor, one share; S. W. Maquay, 1, Whittingstall Road, Fulham, electrical engineer, one share; F. A. Donnison, 116, Great Portland Street, W., electrical engineer, one share; F. Berlyn, 116, Great Portland Street, W., electrical engineer, one share; B. G. Matthews, 116, Great Portland Street, W., electrical engineer, one share; F. W. Fowler, 78, Cricketfield Road, Clapton, N.E., clerk, one share. The number of directors is not to be less than three, nor more than five. Qualification 10 shares; remuneration as fixed by the company. Registered by P. E. Vanderpump & Eve, 5, Philpot Lane, E.C.

Mutual Electric Trust, Limited (50,752).—Registered January 4th, with a capital of £10,000 in £1 shares, to acquire certain letters patent, inventions, and rights relating to the distribution, measurement, and utilisation of electrical energy, to adopt an undescribed agreement, and to carry on the business of electricians, engineers, suppliers of electricity, and electrical apparatus manufacturers. The subscribers (with one share each) are:—F. V. Hobbs, 41, Dyke Road, Brighton, agent; L. Kenward, 142, Westbourne Street, Hove, clerk; P. G. Fitch, 2, Wilbury Avenue, Hove, clerk; Wm. Cowdery, 13, Stanford Road, Brighton, engineer; A. L. Harrison, 33, Stanford Road, Brighton, clerk; H. C. Hughes, 50, Beaconsfield Villas, Brighton, secretary; H. Cluer, 14, Dorset Gardens, Brighton, secretary. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first; qualification £100; remuneration as fixed by the company. Registered office, 111, Gloucester Road, Brighton.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

New Phonopore Telephone Company, Limited (41,132).—This company's registered office has recently been removed from Faraday House, Charing Cross Road, W.C., to 85, Queen Victoria Street, London, E.C.

Electric Sign and General Advertising Company, Limited (45,610).—This company's annual return was filed on December 11th, when 2,000 shares were taken up out of a capital of £5,000, in £1 shares; 1,000 of these are considered as paid, and £1,000 has been called and paid on the rest.

New General Traction Company, Limited (47,321).—This company's statutory return has just been filed. The capital of £170,000, in £5 shares (of which 10,000 are preference), has been taken up, and the ordinary are considered as paid; £5 per share has been called on the preference, and £37,500 has been paid, while £12,500 is in arrears.

Newton Electrical Works, Limited (48,936).—This company's statutory return was filed on November 14th, when 2,100 shares were taken up out of a capital of £30,000 in £10 shares; 1,400 are considered as paid, and £7,000 has been called and paid on the rest.

Electric Motive Power Company, Limited (41,132).—This company's annual return has just been filed. The capital is £20,000, in £1 shares (of which 10,350 are preferred); 7,281 preference and 9,650 ordinary have been taken up, and the latter are considered as paid; £1 per share has been called on the preference, and £7,274 has been received, leaving £7 unpaid.

Electrical Coal-Cutting Contract Corporation, Limited (36,643).—This company's annual return was filed on October 15th. The capital is £402,000, in 60,000 ordinary of £5, 20,000 deferred of £5, and 2,000 founders' shares of £1 each; 9,530 ordinary, and all the deferred and founders', have been taken up, and 4,000 ordinary and the deferred are considered as paid; £5 per share has been called on 5,531 ordinary, and £1 per share on the founders', and £28,375 has been received, leaving £1,280 unpaid.

Morley Fletcher Wave Power System, Limited (48,648).—This company's statutory return has just been filed. The capital is £20,000 in £10 shares, and 422 have been taken up; 213 are considered as paid, and £5 per share has been called on 209, while £985 has been paid, leaving £60 in arrears.

Electricity Users' Association, Limited (40,677).—This company's annual return was filed on October 10th, when 127 shares were taken up out of a capital of £2,000 in £1 shares; £1 per share has been called, and £89 10s. paid, while £37 10s. has yet to be sent in.

CITY NOTES.

The Edison & Swan United Electric Light Company, Limited.

WE have before us copies of a prospectus and other papers which have been issued by this company in connection with the redemption of the existing £100,000 4½ per cent. debenture stock at £10 premium, and the issue of the £200,000 new 4 per cent. debenture stock, redeemable on six months' notice by the company at £10 premium, which is offered to the holders of the existing stock, and to the shareholders of this company and the amalgamated Manchester Edison-Swan Company. Holders of the 4½ per cent. debentures are requested to deposit at this office the certificate for any such debenture stock registered in your name, at least three clear days before the said June 30th, 1897, after which date all interest on the debenture stock will cease. The directors are offering, in lieu of such repayment, an equivalent amount of 4 per cent. debenture stock, that is, £110 of the new stock in exchange for each £100 of the existing stock. Holders wishing to accept this offer must fill up and transmit to Mr. Gover, the secretary, the form which is sent out, accompanied by the certificate of holding, not later than January 15th, 1897, in order that it may be exchanged for the certificate of the new stock, carrying interest from January 1st, 1897. The debenture stock which is now offered is part of an amount limited to £350,000, and subject to be redeemed at the option of the company on 6 months notice, at £110 per cent.

Central London Railway Company, Limited.—A call of £2 per share, payable on February 1st next, has been made on the shareholders. The warrants for the half-year's interest to December 31st, 1896, were posted on the 4th inst., and were payable at Glyn's Bank on the 5th inst.

The City of London Electric Lighting Company, Limited.—We are informed that warrants for payment of interest on the £400,000 debenture stock, for the half-year ended December 31st, were posted last week.

Augusta Railway and Electric Company, Limited.—Coupons due January 1st, 1897, on the bonds of this company, will be paid by the North American Trust Company, 95, Gresham Street, London, E.C.

Hobart Electric Tramway Company, Limited.—Coupon No. 10, in respect of the debenture interest due last week, is payable at the Commercial Bank of Scotland, 62, Lombard Street, E.C.

General Electricity Company of Frankfort.—The General Electricity Company of Frankfort, will shortly issue 4 per cent. obligations for 5,000,000 marks.

Electric Construction Company, Limited.—The transfer books for the first mortgage debentures will be closed from 8th to 14th inst., inclusive.

Globe Telegraph and Trust Company, Limited.—The directors announce an interim dividend of 1s. 6d. per share upon the ordinary shares.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending January 3rd, 1897, were £1,077; week ending January 5th, 1896, £1,017; increase, £60; total receipts for half-year, 1897, £1,077; corresponding period, 1896, £1,017; increase, £60.

The Liverpool Overhead Railway Company. The receipts for the week ending January 3rd, 1897, amounted to £1,374; corresponding week last year, £1,140,; increase, £224.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 1st, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,163.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of December, 1896, were £3,069.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Dec. 30th.	Closing Quotation, Jan. 6th.	Business done during week ended Jan. 6th, 1897. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	4 %	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	8½— 9½	8½— 9½	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	51 — 54	52 — 55	53⅜	52
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	95½ — 96½	96 — 97	97⅞	96¼
2,993,560£	Do. do. Defd.	Stock	...	...	...	9¾ — 10¼	10 — 10⅛	10¼	...
120,000	Brazilian Submarine Teleg., Ltd.	10	6¼% §	7 %	7 %	14⅜— 15¼xd	14⅜— 15¼	15½	14⅞
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	5 %	115 —119	113 —117xd	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	... §	2½%	4 %	3¼— 3⅜	3¼— 3⅜	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —170	160 —170	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	1½%	1½%	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	11⅜— 12½	12 — 13	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½— 19½	18½— 19½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½— 4½	3½— 4½	4½	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	4½%	107 —110 %	105 —108%	...	...
60,710	Direct United States Cable, Ltd.	20	2⅝% §	2 %	2½%	9½— 9⅝	9½— 9⅝	9 9/16	9⅝
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½%	6½%	17 — 17½	17 — 17½	17¼	...
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 %	6	18 — 19	18 — 19	...	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	127 —130	127 —130	129½	128
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17 — 17½	17 — 17½	17½	17 3/16
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	101 —105	100 —104 xd	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	102 —105	101 —104 xd	101½	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	128 —131	128 —131	...	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	101 —105	100 —104 xd	103¾	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	102 —105	101 —104 xd	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	107 —110	108 —111	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	108 —111 %	109 —112 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅜% §	4½%	4½%	10⅜— 11¼	10⅜— 11¼	11	10 13/16
180,042	Do. do. 6 % Pref.	10	6 % §	6 %	6 %	17¼— 17¾	17¼— 17¾	17⅛	17 9/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜%	10 %	24 — 25	24 — 25	25⅜	24½
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	53 — 55	53 — 56	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	109 —112	109 —112	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	4 %	2 — 2¼	2 — 2¼	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 %	5½%	7⅛— 7⅜	7⅛— 7⅜	7⅜	7⅛
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	18	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6¾— 7	6¾— 7	6 15/16	6¾
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 —107 xd	105 —108 xd	107	105¼
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4¼%	5 %	1/16— 1/8	1/16— 1/8	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	108 —111	106 —109 xd	...	...
11,839	Reuter's Ltd.	8	0 %	nil	5 %	7 — 8	7 — 8	7	...
3,381	Submarine Cables Trust	Cert.	...	...	...	138 —143	138 —143	...	...
58,000	United River Plate Teleph., Ltd.	5	...	3 %	4 %	3¼— 3⅜	3¼— 3⅜	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	103 —105 xd	100 —105 xd	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	nil	nil	4 %	5 — 6	5 — 6	...	...
238,380£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 —106	103 —106	...	...
39,000	West Coast of America Teleg., Ltd.	10	nil	nil	nil	0 — 1	0 — 1	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	8 %	93 — 99	89 — 95 xd	92	90½
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	3 %	8½— 8⅝	8½ — 8⅝	...	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½— 6⅝xd	6½— 6⅝	6 9/16	...
33,129	Do. do. do. Def. Ord.	7½	...	1 %	1 %	2½— 3	2½— 2⅝	2½	...
165,200£	Do. do. do. 6% Debs. "A," 1880 Red.	100	6 %	6 %	6 %	105 —109	105 —109	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	105 —109	105 —109	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	⅛%	1¼— 1½	1¼— 1½	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11½— 12	11½— 12	11¾	11 11/16
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9½— 10½	9½— 10½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	109 —112	107 —110 xd	107	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	107 —112	107 —112	...	...
164,200£	Do. do. 5 % Ster. Bonds.	100	6 %	6 %	6 %	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	9¼— 9⅜	9¼— 9⅜	9½	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	8⅛— 8⅜	8⅛— 8⅜	8⅝	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	4½%	112 —115 xd	112 —115 xd	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	15½— 16½	15½— 16½	16	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17½	16½— 17½	17½	17 3/16
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	126 —130 xd	127 —131 xd	...	...
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	...	nil	8 — 9	8 — 9	...	...
20,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	...	6 %	13⅜— 14½	13⅜— 14½	...	...
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	...	7½ -- 8½	9½— 10½	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	4 %	12½— 13½	12½— 13½	13 3/16	13
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem., £1 paid	10	...	...	...	6½— 7	6½— 7	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	119 —122 xd	119 —122 xd	...	...
5,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	10 — 11	10 — 11	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	12 — 13	12 — 13	12 3/16	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9½ — 10½	9½ — 10½	10⅛	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	104 —107 xd	104 —107 xd	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	4 %	5 %	7 %	11 — 12	11 — 12	11⅜	11 5/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

§ Dividends marked § are for a year consistin[illegible] of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Dec. 30th.	Closing Quotation Jan. 6th.	Business done during week ended Jan. 6th, 1897. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	S	5 %§	2½%	...	⅞ — 1	⅞ — 1	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %§	3 %	...	1 — 1¼	1 — 1¼	...	...
125,000	Do. do. 4½ % Perp. Deb. Stock... ...	Stock	4½%	4½%	...	110 —113	110 —113	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ..	Stock	...	...	...	94 — 98 xd	94 — 98 xd	...	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	9⅜— 10¼	9⅜— 10¼	...	...
207,649	Do. do. do. £4 paid	10	...	...	...	3⅞— 4⅛	3¼— 4	...	...
630,000	City and South London Railway	Stock	1½%	1½%	1 5/16%	54 — 56	54 — 56	56	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 %§	*nil*	*nil*	1⅜ — 2¼	1⅜ — 2¼	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	5 %	1⅜— 2¼	1⅜— 2¼	1⅜	...
17,139	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	5 %	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	4½%	102 —105 xd	105 —110 xd	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	5 %	1⅜— 1⅝	1⅜— 1⅝	...	1 9/16
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2½— 3	2½— 3	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	⅜— ⅝	⅜— ⅝	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	¼— ½	¼— ½	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	10½%	10½— 11½	10½— 11½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	17½ — 18½	17½ — 18½	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	109 —114	109 —114	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	20½ — 21½	20½ — 21½	21½	21½
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	105 —108	105 —108	...	...
37,500	Liverpool Overhead Railway, Ord.	10	1 %	1½%	2⅝%	14 — 14½	14 — 14½	...	...
10,000	Do. do. Pref., £10 paid	10	5 %	5 %	5 %	17 — 17½	17 — 17½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	39 — 42	40 — 43	41½	40½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	102 —105 xd	..	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £6 paid ...	10	...	...	...	7½— 8	7½— 8	8⅛	7⅞

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1893—0%; 1891—7%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9⅛.
Electric Construction Corporation, 6 % Debentures, 102—104 xd
House-to-House Company (£5 paid), 4½—5.
Do. do 7 % Preference, of £5, 9 –9½.
Do. do 4½% Debentures of £100 107—109 xd.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 10—10½; 1st Preference Cumulative 6 %, £5 (fully paid), 8½—8⅝.
London Electric Supply Corporation, £5 Ordinary, 1—1½.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6⅜—7½

* From Birmingham Share List.

Bank rate of discount, 4 per cent. (October 22nd, 1896).

ON ARMATURE REACTIONS OF DYNAMO MACHINES.*

BY ALEXANDER ROTHERT.

(*Continued from page* 827, *Vol.* 39.)

POLYPHASE MACHINES.

POLYPHASE machines have, according to the usual way of looking at them, much in common with direct current machines; for example, the armature currents produce a continuous magnetising force, whereas in alternate current machines a periodic pulsating armature reaction is developed. The polyphase machine, therefore, is to be looked upon as an intermediate step between the direct and alternating current machines. The usual assumptions, without which any diagram would be impossible, are the following:—

1. Each alternating current has the sine form.
2. The magnetising forces of each phase can be combined by the parallelogram of forces to a constant magnetising force of the armature, which rotates with the same speed as the magnetic field.

These assumptions are, of course, not strictly accurate; they make possible, however, a simple diagrammatic treatment of all alternate current problems, and the results agree remarkably well with practice. Of all polyphase systems the Drehstrom is the best known, and most generally used. The following investigation, therefore, refers to Drehstrom generators, but it is easy to apply the results obtained to other polyphase systems.

It has been often proved (Ferraris, Sahulka, and Arnold) that, making the above assumptions, the magnetising forces and, with constant permeability, also the magnetic fields, can be geometrically combined to a single constant Drehfield. The resultant magnetising force of a Drehstrom system is equal to one and a half times the amplitude of a phase.

* *Elektrotechnische Zeitschrift*, Vol. 17, p. 575.

The resultant ampere turns of a Drehstrom armature is therefore $= 1{\cdot}5\sqrt{2} \times$ number of turns $\times$ current strength of a phase, if we substitute the effective current strength of a phase for the amplitude. The correctness of this construction can be easily seen from the following diagram (fig. 6).

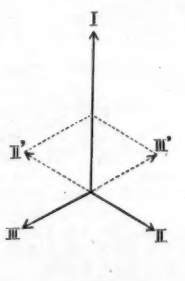


FIG. 6.

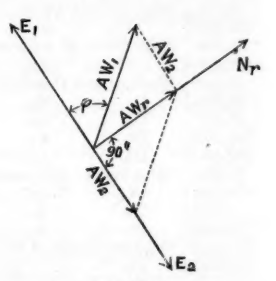


FIG. 7.

The winding of a Drehstrom armature, as is well known, is accomplished in such a way that the windings of the three phases are separated from one another by 120° (360° corresponds here to the circumference of the armature divided by half the number of poles). At the moment when the current of phase I is exactly at its amplitude, the currents of the other phases, II and III, are exactly equal, and being separated by 120°, they are each exactly half of I. In consequence of the already mentioned angular relation of the windings of the three phases, the three instantaneous values may be represented as in fig. 6. I, II, III are the three currents, *i.e.*, the magnetising ampere turns, in magnitude and direction. The arrangement of the three phases is, however, such that the magnetising forces act in the same sense, and have therefore the direction of the dotted lines, II^1 and III^1. If we now combine II^1 and III^1 geometrically, the resultant lies in the direction of I, and is in amount

equal to one-half I. The sum of the resultants of all the three magnetising ampere turns is, as already stated above, $1\frac{1}{2}$ times the amplitude of the magnetising ampere turns of one phase.

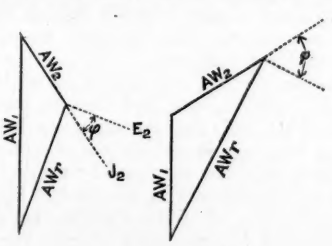
We have now, therefore, reduced the problem to the same basis as in the case of the direct current dynamos. We have again two component ampere turns, A W_1, of the magnet coils, and A W_2 of the armature, and the resultant of the two, A W_r, which produces the active magnetic field, N_r.

In many respects, however, there are essential differences between direct current machines and Drehstrom machines. In the case of the former, the direction of A W_2 was given by the position of the brushes, and only when the brushes were placed at the points of minimum sparking was A W_2 perpendicular to A W_r. With the Drehstrom machines the conditions are somewhat different.

The direction of the E.M.F. is always perpendicular to the field producing it. Neglecting the magnetic leakage as before, N_r is the only really active field; the E.M.F. must therefore be perpendicular in direction to N_r, and therefore perpendicular to A W_r. If there is no self-induction in the external circuit of the machine, J^2, the armature current, and A W_2 is at right angles to N_r, and the diagram is similar to fig. 1; it is exactly the same diagram as in the case of a transformer, where we have primary, secondary and resultant ampere turns, of which the latter creates the magnetic field, and is perpendicular to both the E.M.F's. Fig. 7 represents the transformer diagram, which, for the sake of comparison, is drawn in the same position as fig. 1. We see, therefore, that the recently introduced idea of the universal transformer can be extended also to generators. In the case of the transformer the angles between the magnitudes represent merely succession in time, while, in the case of the Drehstrom generator and motor, they give the instantaneous space relations of the resulting vector quantities.

If we now follow out the application of this method of representation to armature reaction, we obtain the same results as from the known self-induction theories of alternating and polyphase machines. The characteristic of a Drehstrom generator for constant excitement and an inductionless load is, according to the construction in fig. 4, an ellipse, if the permeability of the magnetic circuit is considered to be constant. But by our method, the characteristic may be constructed without this assumption, by the help of the magnetic curve of the iron used. Likewise the increase of excitement, necessary to keep the E.M.F. constant, as the load increases may be easily determined by a construction similar to that in fig. 5. In this case A W_r = C B remains constant; and for each value of A W_2 = C B, a value A B = A W_1 is obtained.

All the relations for inductive loading come out equally simple. If, for example, magnetic fields act inductively on the external circuit, a difference of phase between E.M.F. and current arises. A W_2 is now no longer perpendicular to A W_r, but makes with the perpendicular an angle, ϕ (fig. 8), equal to the retardation of phase. It can be easily seen



FIGS. 8 AND 9.

from this figure, without further proof, that the greater the retardation of the phase of the current, the more important becomes the armature reaction.

If instead of self-induction in the external circuit there is a condenser or an over-excited synchronous motor with phase acceleration, the conditions are reversed. As fig. 9 shows, the armature reaction is then negative, *i.e.*, an increase of the load involves a decrease of the excitement. Fig. 10 gives us a picture of the armature reaction for one and the same armature current in the relation to the direction and magnitude of the phase displacement. Both A W_2 and A W_1 are constant. The end points of A W_r lie for different phase displacements upon a circle whose radius P Q = A W_2; P Q, P Q', &c., are the different directions of A W_2; O Q, O Q', &c., are values A W_r.

It is evident, therefore, that we have arrived in a quite elementary way at results similar to those which have hitherto been obtained by means of the theory of self-induction. It is not necessary to treat the influence of phase displacement separately, but this falls naturally within the

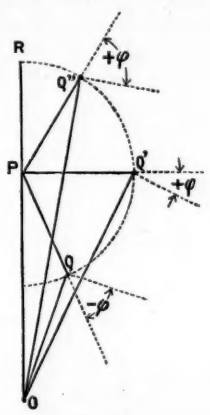


FIG. 10.

purview of the constructor, since it determines the direction of the ampere turns. But our method offers still greater advantages, when we take the by no means unimportant influence of magnetic leakage into consideration.

INFLUENCE OF MAGNETIC LEAKAGE.

If we apply to the magnetic circuit a law analogous to that of Ohm, we must not forget that the surrounding air also conducts magnetism; the magnetic core is therefore analogous to a live conductor surrounded by water. According to Ohm's law, the current in this case divides itself in proportion to the relative conductivities; the greater part goes through the metallic conductor, a very small part goes through the surrounding medium. Exactly the same takes place in the magnetic circuit. Fig. 11 represents a magnetic circuit as it occurs in practice.

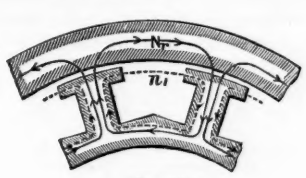


FIG. 11.

The coils upon the core of the magnet produce the desired stream of lines of force, N_r, the armature being as yet considered to be without current. As may be seen from fig. 11, a number of lines of force pass over directly between the poles without passing through the armature. The ratio of this stray field, n_1, to the principal field, N_r, is the inverse of the ratio of the magnetic resistances, both fields being equal to the ampere turns on the magnet divided by the respective magnetic resistance. After the magnetic resistance of the stray field has been measured or calculated, the primary magnetic leakage, n_1, can easily be measured. As we have seen, the number of lines of force in the magnet core is greater than in the armature, *i.e.*, $N_1 > N_r$. We have thus a field, N_r, which passes through both systems, and a primary stray field, n_1, which passes through the primary system only.

Exactly the same reasoning applies to the leakage of the armature. The current flowing through the armature coil likewise produces a magnetising force which acts upon the same magnetic circuit as the magnet coils. Both magnetic forces must, as already stated, be combined geometrically, and the resultant ampere turns are those which produce the resultant magnetic field, N_r, which passes through both

systems. But the magnetising force of the armature also produces a stray field, which in direction and magnitude depends on A W_2 only. This secondary stray field has, therefore, the direction of the armature current in the diagram.

The primary and secondary ampere turns, A W_1 and A W_2, are combined geometrically, as already described, to give the resultant ampere turns, A W_r. The field, N_r, produced by these resultant ampere turns, may be calculated by Hopkinson's method for the particular circuit in question. This N_r must lie in the same direction as A W_r; it is, therefore, drawn parallel to A W_r in fig. 12. In addition to N_r, there passes through the magnet core the primary stray field, n_1, which must lie in the same direction as, and be proportional to, A W_1. N_r, combined with n_1, gives the resultant N_1, as

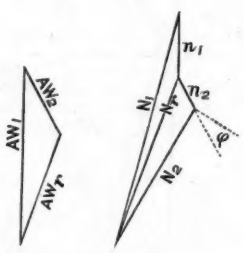


Fig. 12.

shown in fig. 12. The armature stray field, n_2, combined with N_r, gives the resultant, N_2. We thus obtain the number of lines of force, N, which actually passes through the magnet core, and the number, N_2, actually passing through the armature, and thereby producing the E.M.F. We have thus to deal with only one E.M.F. which is really present. It is perpendicular to N_2; and with inductionless load the current, and therefore A W_2 and n_2, must be perpendicular to N_2. With inductive loading and neglecting the loss of E.M.F. in the wire of the armature, the angle between n_2 and the perpendicular upon N_2 (*i.e.*, the E.M.F.) is equal to the angle of phase displacement, ϕ.

The principal advantage of this method is that we have to deal with only one strength of field, and consequently only one E.M.F.; and the hysteresis and eddy current losses in the iron corresponding to this field can be easily calculated. If we know the amounts of the magnetic leakage, *i.e.*, the ratio between the magnetic resistances of the principal field and the stray fields, n_1 and n_2, we can, by the Hopkinson method, draw the complete diagram for any load, and any phase displacement, and determine the fall of potential with the increase of excitement.

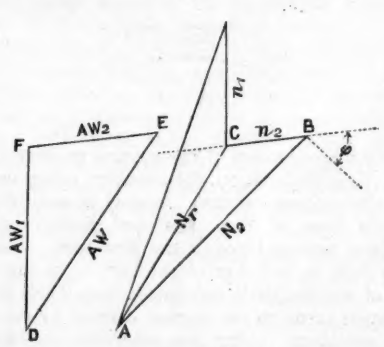


Fig. 13.

This process is generally still further simplified in practice by the fact that the magnetic resistance of iron is small compared with that of air. In well designed machines, where the leakage is not abnormally high, and the magnet cores are not saturated, the magnetic resistance may be taken as constant.

This assumption enables us to neglect the primary leakage; and the problem is thereby very much simplified.

The question of determining the necessary excitement for a given inductionless or inductive load, takes the following form when the magnetic leakage is known:—

We draw first to any scale A B = N_2, the field corresponding to the given E.M.F. and perpendicular to A B at B, the direction of the E.M.F. At an angle of ϕ (here, lead, due to a condenser, or over excited synchronous motor) the direction of the current is drawn. In this direction lies the armature stray field, n_2, the magnitude of which is determined from the strength of the currents, N_2 and n_2, which are combined to produce the resultant, N_r. Parallel to N_r we draw A W_r = D E, the resultant ampere turns, the amount of which can be calculated by the Hopkinson method. From the current strength and the number of turns we calculate A W_2 = E F, and draw it parallel to B C from E. D F is then our A W_1, the primary ampere turns, from which, when the number of turns in the magnet coils is known, the necessary exciting force can be calculated.

We can now ascertain whether the primary magnetic leakage, n_1, which is calculated from A W_1, can be neglected. For this purpose draw n_1 from the point, C, parallel to D F, and find the resultant, N_1. It can now be investigated whether the addition of the leakage will saturate the magnetic core to such an amount as to make an important increase in the magnetic resistance. If it is found to do so, the necessary correction can be made.

It will be evident, without further explanation, that all these considerations and constructions can be applied to direct current machines, with the distinction, however, that the direction of the armature ampere turns, A W_2, is determined by the position of the brushes, and that no phase displacement exists. It is therefore unnecessary to specially consider magnetic leakage in the case of direct current machines. We will therefore next consider the last category of machines, namely, single phase alternating machines.

(*To be continued.*)

REVIEWS.

Motive Power and Gearing for Electrical Machinery. By E. Tremlett Carter, C.E. Price 12s. 6d. Published by the *Electrician* Printing and Publishing Company, Limited, London.

This is a book of 600 pages, printed in good readable type, and containing a large number of indistinct pictures.

The author has collected into one volume a large quantity of valuable information previously published in disconnected papers and reports; but it is by no means up to date. For instance, we find several pages devoted to an exposition of the Willans law, applicable to throttle valve engines, in the course of which this sentence occurs: "But we do not know, at any rate with the same degree of exactitude, what the corresponding law is for other types of engines, such as the horizontal engine, with regulation by automatic cut-off;" yet it is more than a year since Captain Sankey read his paper before the Institution of Mechanical Engineers, in which he explained in most masterly fashion the theoretical relation between the curve of automatic expansion and the Willans straight line diagram.

A page devoted to the overloading of engines deals only with throttle valve engines, and fails to mention the one vital fact that the only engines which can be overloaded as occasion may require, and without loss of economy at normal loads, are those which are regulated by varying the cut-off.

Probably the best picture in the book is fig. 91, showing a longitudinal section of Willans engine, but even this does not show the latest improvements whereby the formation of little ponds of condensed water, which used to surround the internal glands between the cylinders, has been prevented.

In connection with the Willans engine, it is important to notice a rather serious error on page 262. "With a Willans *compound* unjacketed condensing engine of large power, a consumption of 14·87 lbs. per I.H.P. hour, equal to 16·25 lbs. per brake H.P. hour, has been attained; and the same engine, working without a condenser, was found to consume 18·25 lbs. per I.H.P. hour, or about 20·3 per B.H.P. hour." This was the engine described by Mr. Willans in the discussion on Mr. Crompton's paper on "Electrical Energy," April, 1891, and Mr. Willans distinctly stated that this engine was a *triple*.

The same engine, when worked as a compound, took 21·5 lbs. per I.H.P. hour non-condensing.

In the chapter on engine tests, a "Tabor" indicator is described, but the all but universal "Crosby" is not even mentioned.

The chapter on governors is merely descriptive of various patterns, but omits all mention of Lindley's "Acme," and of the Porter governor, and we consider that the description of crankshaft governors is seriously marred by the statement that the governor alters the angle of advance of the eccentric without any mention of the fact that it, at the same time, alters the stroke. The various devices employed to obtain this motion form the most interesting features of shaft governors, and considering the rapidity with which this pattern of governor is advancing, it is very important that they should be understood.

In the Turner-Hartnell governor the eccentric is moved through an arc, of which the centre is placed near the rim of the pulley. In the Armington-Sims, two eccentrics, one inside the other, are moved in opposite directions. The conditions of success with this form of governor are:—Enormous power, large wearing surfaces, and minimum friction.

About half the book is devoted to steam, then follow chapters on gas and oil engines, turbines, various forms of gearing and methods of coupling, descriptions of typical power stations, and seven appendices containing some useful tables, a description of Halpin's thermal storage, some electrical supply station data, and an illustrated account of the Raworth Universal engine.

As a whole, the book contains a mass of valuable information which has not previously been combined in a handy form for reference.

Constructional Steel and Ironwork. By FRANCIS CAMPIN, C.E. London: Crosby, Lockwood & Co. 1896.

One of the new issue of Weale's Scientific and Technical Series, the aim of this book is to afford elementary information to architectural and building students, and it may not be without its value to many whose student days are long past. There is a good deal of sound information between the two covers relative to the connection of pillars in storied buildings, the support of girders upon walls, and the keeping free of walls of the end columns. The general practical details of construction are explained, and we consider the book to be sound and practical. We note a mistake on page 53, where the sign + has been placed wrongly thus ×.

Elementary Engineering. By JOHN SHERREN BREWER. London: Crosby, Lockwood & Son. 1896.

The well-known Weale's series of technical volumes is now being re-issued, but in a new form, and the present volume is one of the new series. The title of the present volume is somewhat contorted, as it is with marine engineering that it deals more particularly. The information in the book is almost entirely in the form of a catechism. This, we think, is a mistake. The questions take up more room we should think than the few words necessary to connect the whole into a continuous narrative. There is something exceedingly aggravating in the catechetic form of giving information which obtained years ago in such publications as the "Child's Guide to Knowledge." It is an out of date and antiquated system, that ought certainly not to have been carried out in a new series, and we cannot understand how it has been allowed. Apart from this error, as we look through the book we do not see any particular cause to complain of the contents. Certainly much of the information is very elementary, and consists, moreover, of very bare statements of fact. At the same time there are lacking explanations that ought to have been included. Thus, in describing a puddling furnace, we are told that the furnace is "fettled" with "puddler's mine" and "bull dog"; technical terms of the art that are meaningless to the outsider. Perhaps the word "fettled" is understood by very few. It is applied to furnaces very generally, but otherwise is almost confined to Lancashire as a term in daily use.

A few of the descriptions are very short, and had better have been either extended or omitted. Especially is this the case with the steam engine indicator, which is described in a manner entirely useless to a young reader. Had the questions been omitted, and the large amount of leaded space saved and utilised, the value of the book would have been considerably enhanced.

Induction Coils and Coil-Making. By F. C. ALLSOP. Second Edition. London: E. & F. N. Spon, 125, Strand.

This useful little book has, we should say, been much appreciated, and it is not surprising that a further edition has become necessary. The additions which have been made, including, of course, a chapter on Röntgen photography, have materially added to the utility of the work, which indeed might be extended still further with advantage. Chapter VI., on "Experiments with Spark Coils," is rather significant in its brevity, consisting as it does of six pages only, and hardly bears out the author's statement that "a large number of experiments are capable of being performed with a good spark coil." Our own experience is distinctly to the effect that, fascinating though the construction of a spark coil is, it is not by any means an apparatus that admits of much variety of experiment.

ON THE MAGNETIC PERMEABILITY OF LIQUID OXYGEN AND LIQUID AIR.

BY J. A. FLEMING, M.A., D.Sc., F.R.S., and JAMES DEWAR, LL.D., F.R.S.*

THE remarkable magnetic properties of liquid oxygen were pointed out by one of us in a communication to the Royal Society in 1891,† and were subsequently described to the Royal Institution in a lecture delivered in 1892.‡ We have for some time past directed our attention to the question of determining the numerical values of the magnetic permeability and magnetic susceptibility of liquid oxygen, with the object of determining not only the magnitude of these physical constants, but also whether they vary with the magnetic force under which they are determined.

Although a large number of determinations have been made by many observers of the magnetic susceptibility of different liquids taken at various temperatures, difficulties of a particular kind occur in dealing with liquid oxygen. One method adopted for determining the magnetic susceptibility of a liquid is to observe the increase of mutual induction of two conducting circuits suitably placed, first in air, and then when the air is replaced by the liquid in question, the susceptibility of which is to be determined. A second method consists in determining the mechanical force acting on a known mass of the liquid when placed in a non-uniform magnetic field. Owing to the difficulty of preserving any quantity of liquid oxygen from evaporation for any length of time, even in a good vacuum vessel, and the impossibility of sealing it up in a bulb or tube, and having regard to the effect of the low temperature of the liquid in deforming by contraction and altering the conducting power of coils of wire placed in it, it was necessary to devise some method which should be independent of the exact constancy in mass of the liquid gas operated upon, and independent also of slight changes in the form of any coils of wire which might be used in it. After many unsuccessful preliminary experiments, the method which was finally adopted as best complying with the conditions introduced by the peculiar nature of the substance operated upon is as follows:—

A small closed circuit transformer was constructed, the core of which could be made to consist either of liquid oxygen or else immediately changed to gaseous oxygen, having practically the same temperature. This transformer consisted of two coils, the primary coil was made of 47 turns of No. 12 S.W.G. wire, this wire was wound into a spiral, having a rectangular shape, the rectangular turns having a length of 8 cm. and a width of 1·8 cm. This rectangular-sectioned spiral, consisting of one layer of wire of 47 turns, was bent round a thin brass tube, 8 cm. long and 2½ cm. in diameter, so that it formed a closed circular solenoid of one layer of wire. The wire was formed of high conductivity copper, doubly insulated with cotton, and each single turn or winding having a rectangular form.

The turns of covered wire closely touched each other on the inner circumference of the toroid, but on the external circumference were a little separated, thus forming apertures by which liquid could enter or leave the annular inner core.

The nature of this primary coil is shown in fig. 1.

The mean perimeter of this rectangular-sectioned endless solenoid was 13½ cm., and the solenoid had, therefore, very nearly 3·5 turns

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* Received November 20th. Read before the Royal Society, November 26th, 1896.

† Roy. Soc. *Proc.*, December 10th, 1891, Vol. 1, p. 24. See a letter to the President by Prof. James Dewar, F.R.S.

‡ See Roy. Inst. *Proc.*, June 10th, 1892, "On the Magnetic Properties of Liquid Oxygen." Friday evening discourse, by Prof. J. Dewar.

per cm. of mean perimeter. When immersed in liquid oxygen a coil of this kind will carry a current of 50 amperes. When a current of A amperes is sent through this coil the mean magnetising force in the axis of this solenoid is, therefore, represented by 4·375 times the current through the wire, hence it is clear that it is possible to produce in the interior of this solenoid a mean magnetising force of over 200 C.G.S. units. This primary coil had then wound over it, in two sections, about 400 or 500 turns of No. 26 silk-covered copper wire to form a secondary coil. The primary and secondary coils were separated by layers of silk ribbon. The exact number of turns was not counted, and as will be seen from what follows it was not necessary to know the number. The coil so constructed constituted a small induction coil or transformer, with a closed air-core circuit, but which, when immersed in a liquid, by the penetration of the liquid into the interior of the primary coil, became changed into a closed circuit transformer, with a liquid core. The transformer so designed was capable of being placed underneath liquid oxygen contained in a large vacuum vessel, and when so placed formed a transformer of the closed circuit type, with a core of liquid oxygen. The coefficient of

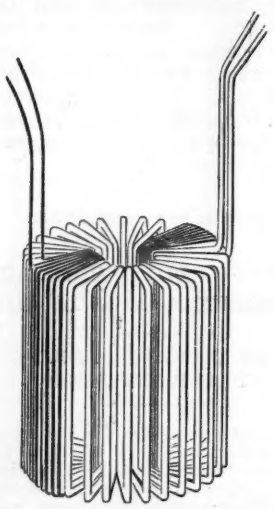

Fig. 1.—Diagram of the Closed Circuit Transformer used in the Experiments.

mutual induction of these two circuits, primary and secondary, is therefore not affected by immersing the transformer in liquid oxygen, because the whole of the induction produced in the interior of the primary coil is always linked with the whole of the turns of the secondary coil, and the only change that can be made is a small change in the mean perimeter of the primary turns due to the contraction of the coil as a whole. In experiments with this transformer the transformer was always lifted out of the liquid oxygen into the cold gaseous oxygen lying on the surface of the liquid oxygen, and which is at the same temperature. On lifting out the transformer, the liquid oxygen drains away from the interior of the primary coil, and is replaced by gaseous oxygen of very nearly the same temperature.

The vacuum vessel used had a depth of 60 cm. outside and 53 cm. inside, and an internal diameter of 7 cm. It held 2 litres of liquid oxygen when full; but, as a matter of fact, 4 or 5 litres of liquid oxygen were poured into it in the course of the experiment.

Another induction coil was then constructed, consisting of a long cylindrical coil wound over the four layers of wire, and a secondary circuit was constructed to this coil, consisting of a certain number of turns wound round the outside of the primary coil, and a small adjusting secondary coil, consisting of a thin rod of wood wound over with very open spirals of wire. The secondary turns on the outside of the primary coil were placed in series with the turns of the thin adjusting coil, and the whole formed a secondary circuit, partly outside and partly inside the long primary cylindrical coil, the coefficient of mutual induction of this primary and secondary coil being capable of being altered by very small amounts by sliding into or out of the primary coil the small secondary coil. This last induction coil, which will be spoken of as the balancing coil, was connected up to the small transformer, as just described, as follows:—

The primary coil of the small transformer was connected in series with the primary coil of the balancing induction coil, and the two terminals of the series were connected through a reversing switch and ammeter with an electric supply circuit, so that a current of known strength could be reversed through the circuit, consisting of the two primary coils in series. The two secondary coils, the one on the transformer and the one on the balancing induction coil, were connected in opposition to one another through a sensitive ballistic galvanometer in such a manner, that on reversing the primary current, the galvanometer was affected by the difference between the electromotive forces set up in the two secondary coils, and a very fine adjustment could be made by moving in or out the adjusting coil of the balancing induction coil.

The arrangement of circuits is shown in fig. 2.

For the purpose of standardising the ballistic galvanometer employed, the primary coil of the balancing induction coil could be cut out of circuit, so that the inductive effect in the ballistic galvanometer circuit was due to the primary current of the closed circuit transformer alone. A resistance box was also included in the circuit of the ballistic galvanometer. The resistance of the ballistic galvanometer was about 18 ohms, and the resistance of the whole secondary circuit 30·36 ohms. The experiment then consisted in first balancing the secondary electromotive forces in the two coils exactly against one another, then immersing the transformer in liquid oxygen, the result of which was to disturb the inductive balance, and in consequence of the magnetic permeability of the liquid oxygen coil being greater than unity, a deflection of the ballistic galvanometer was observed on reversing the same primary current. The induction through the primary circuit of the small transformer is increased in the same proportion that the permeability of the transformer core is increased by the substitution of liquid oxygen for gaseous oxygen, and hence the ballistic deflection measures at once the amount by which the magnetic permeability of the liquid oxygen is in excess over that of the air or gaseous oxygen forming the core of the transformer when the transformer is lifted out of the liquid. As a matter of fact it was never necessary to obtain the inductive balance precisely. All that was necessary was to observe the throw of the ballistic galvanometer, first when the transformer was wholly immersed under the surface of liquid oxygen, and, secondly, when it was lifted out into the gaseous oxygen lying on the surface of the liquid, the strength of the primary current reversed being in each case the same. In order to standardise the galvanometer and to interpret the meaning of the ballistic throw, it was necessary to cut out of circuit the primary coil of the balancing induction coil, and to reverse through the primary circuit of the small transformer a known small primary current, noting at the same time the ballistic throw produced on the ballistic galvanometer, this being done when the transformer was underneath the surface of liquid oxygen. It will be seen, therefore, that this method requires no calculation of any coefficient or mutual induction, neither does it involve any knowledge of the number of secondary turns on the transformer, nor of the resistance of the secondary circuit; all that is necessary for a successful determination of the magnetic permeability of the liquid oxygen is that the secondary circuit of the transformer should remain practically of the same temperature during the time when the throw of the ballistic galvanometer is being observed, both with the transformer underneath the liquid oxygen and out of the liquid oxygen. If, then, the result of reversing a current of A amperes through the two primary coils in series when the secondary coils are opposed is to give a ballistic throw, D, and if the result of reversing a small current a amperes through the primary coil of the transformer alone is to produce a ballistic throw, d, then if μ is the magnetic permeability of liquid oxygen, that of the gaseous oxygen lying above the liquid and at the same temperature being taken as unity, we have the following relation:—

$$\frac{\frac{D}{A}}{\frac{d}{a}} = \mu - 1,$$

which determines the value of μ.

Deferring for a moment the correction to be applied to determine the value of the magnetic permeability of liquid oxygen in terms of that of a vacuum, the following are the results of observation:—

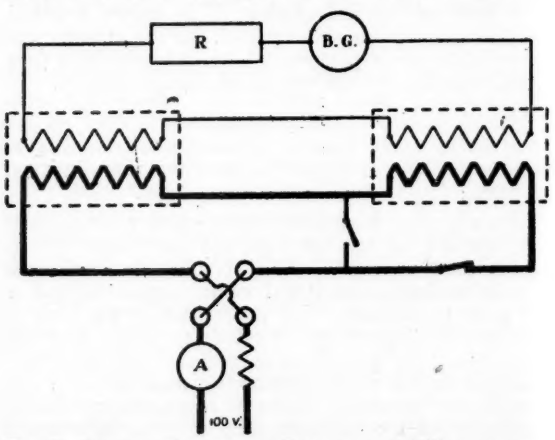

Fig. 2.—Arrangement of the Circuits of the Transformer and Induction Coil.

Observations on Magnetic Permeability of Liquid Oxygen.

Throws of Ballistic Galvanometer. Induction Coils balanced.

Exp. I.	4·0 mm. to left 4·2 „ „ 4·3 „ „	The transformer in liquid oxygen. Primary current = 37·8 amperes reversed through primary coils.
Exp. II.	17·0 mm. to right 17·5 „ „ 18·5 „ „	The transformer lifted out of liquid oxygen into cold gaseous oxygen at the same temperature. Primary current 37·8 amperes reversed through primary coils.
Exp. III.	3·2 mm. to left 2·5 „ „ 2·8 „ „	The transformer in liquid oxygen. Primary current = 37·2 amperes reversed through primary coils.
Exp. IV.	20·0 mm. to right 21·0 „ „ 21·3 „ „	The transformer lifted out of liquid oxygen into cold gaseous oxygen at the same temperature. Primary current = 36·8 amperes reversed through primary coils.

Throws of Ballistic Galvanometer in Standardising Observations.
Primary Coil of Balancing Coil disconnected.

Exp. V.	24·0 mm. to right 25·0 „ „ 25·0 „ „ 24·5 „ „ 25·0 „ „	Corresponding to 0·1145 ampere reversed through primary coil of the transformer, the transformer being in liquid oxygen. The mean of these ballistic throws is the quantity denoted by *d*, and the current 0·1145 ampere is the *a* in the formula above.

Standardising Observations repeated with another Current.

Exp. VI.	58·0 mm. to right 58·0 „ „	Corresponding to 0·2639 ampere reversed through primary coil of transformer, the transformer being in liquid oxygen.

Throws of Ballistic Galvanometer. Induction Coils balanced.

Exp. VII.	4·0 mm. to right 4·0 „ „	The transformer lifted out of liquid oxygen into cold gaseous oxygen at same temperature. Primary current = 8·037 amperes reversed through primary coils.
Exp. VIII.	0·4 mm. to left 0·4 „ „ 0·2 „ „	The transformer in liquid oxygen. Current = 8·095 amperes reversed through primary coils.
Exp. IX.	4·5 mm. to left 4·8 „ „ 4·2 „ „	The transformer in liquid oxygen. Current = 28·8 amperes through primary coils.
Exp. X.	12·0 mm. to right 12·0 „ „ 12·2 „ „	The transformer lifted out of liquid oxygen into cold gaseous oxygen at the same temperature. Current = 28·1 amperes reversed through primary coils.
Exp. XI.	1·2 mm. to left 1·3 „ „	The transformer in liquid oxygen. Current = 28·1 amperes reversed through primary coils.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

The Institution of Junior Engineers.

AT the meeting of this Institution held at the Westminster Palace Hotel on December 18th, the chairman, Mr. H. B. VORLEY, presiding, a paper was read by Mr. P. W. MCDOUGALL, A.I.E.E., on "ELECTRIC CENTRAL STATION WORKING."

With reference to the choice of a suitable site for an electric light station, the author stated that it depended upon two questions: (1) Whether the system to be adopted be high or low pressure. (2) The relative cost between any proposed sites of obtaining the daily supplies of fuel. Low-pressure stations had to be close to the consumers, but those of high-pressure could be placed right away on inexpensive ground and with a river frontage. This was a great advantage, not only from the fact that any quantity of water could be obtained for condensing purposes, but also on account of the facility with which seaborne coal could be brought to the station.

As to boilers, the marine type was most suitable for an electric supply station, where quick steaming was an essential quality. A marine boiler economised a large amount of space over several kinds of boilers of the same evaporative power, and it also required to be less frequently cleaned. The boiler often met with in electricity works was of the water-tube type, but for several reasons it was unsuitable, especially where the feed-water was bad, in which case frequent cleaning was necessary, and the cost of maintenance was a very heavy item in the running expenses of the station. In certain feed-waters there were many impurities which combined to form very hard corrosive scales, the hardest thing being that produced by hydrate of magnesia. A dangerous scale also was that created by cylinder oil carried with the exhaust steam into the hot well and fed back into the boilers again; the oil formed a greasy scale on the boiler plates, and being non-porous, although soft, prevented the water from coming into contact with the plates, resulting in overheating and giving way under pressure. Owing to the fact that these impurities behaved so differently when subjected to high temperatures, and also that it was by no means an easy matter to perform experiments with water when under the normal working conditions of a boiler, chemists could only surmise the exact amount of disintegration and combination of the several impurities contained in water.

Electric light engines used to drive alternators should have as even a turning moment on the crank shaft as possible, so as to ensure satisfactory parallel running. The latest addition to the Deptford station of the London Electric Supply Corporation, which was designed by Mr. P. Walter d'Alton, engineer-in-chief, had this quality in a very high degree. It was a direct coupled plant. The engine consisted of three separate compound engines with cylinders tandem fashion on a three throw crank shaft with cranks at 120°. The alternator was of the Ferranti type and generated 100 amps. at 10,000 volts at a speed of 150 revolutions per minute. The design of the armature, which was built on to the rim of a wheel 16 feet diameter, was very open, and, therefore, gave plenty of ventilation and ensured cool running. The governors were either of the throttle or expansion type. The expansion governor was perhaps more generally the practice in electric light stations, but although the throttle governor was often considered not at all suitable for electric light engines where steady governing and economy were such important matters, it had been adopted in some stations with very satisfactory results, especially when the engines were non-condensing. Whatever the type of governor used, it was a matter of first importance that all the governors should have as near as possible the same range of sensitiveness. If an engine had a governor which allowed a variation of 1 per cent., another of 2 per cent., then when put into parallel, the one would work against the other, and the load would not be divided evenly and great unsteadiness of the light would result, and perhaps failure of the dynamos.

Alternators could be excited either by small continuous-current dynamos driven by separate steam engines, or by ropes from the alternator shaft, or by rectified current from the alternator. The rectifier method had not proved an unqualified success; the regulation not being satisfactory, a slight variation in the speed of the engine producing a very considerable variation in the voltage of the alternator. The exciters were often a weak part of an alternating station. There should be one for each alternator, but not run in parallel, on to a bus bar; and in the author's opinion, should be driven by ropes off the alternator shaft, and made of ample size, so that the exciting system may not need any special attention on the part of the engineer-in-charge.

With regard to the mains and their insulation, paper saturated with Ozokerite (earth-wax) or resinous oil had given very satisfactory results in high-tension work. Ozokerite as a dielectric was developed by patents of Mr. S. Z. de Ferranti, whose concentric armoured cable insulated with waxed paper had been in use some time by the L. E. S. Co. to transmit the current from Deptford to London at 10,000 volts.

The switching gear of a large central station was generally rather complicated, and in a high-tension station the switches had not only to be sure in their action of "breaking" the current, but great care had to be taken that they were well insulated, so that the operator was not endangered. The high-tension switches at Deptford which had been redesigned by the company's own engineers, consisted of a long light gun-metal arm worked by a lever of the signal-box pattern. The "break" was 4 feet 6 inches, and being high up overhead, perfect safety was assured. There had been no difficulty in "breaking" the current with the machine working at full speed, *i.e.*, 100 amps. at 10,000 volts, and also on a short circuit.

Owing to certain effects due to the capacity and length of the trunk mains from Deptford, it had not been possible to put on a main or withdraw it suddenly by pulling off a plug, without producing a variation in the voltage on the system. But this had been successfully overcome by an arrangement suggested by Mr. G. W. Portridge of the L. E. S. Co. The main was connected to the bus bar through a high inductive resistance and was gradually charged to the required potential by reducing the induction. As soon as the potential on the main was equal to that of the bus bar, then the main plug was inserted and the discharger disconnected. The reverse operation was performed when it was necessary to withdraw the main from commission.

Arc lamps supplied by Ferranti rectifiers was perhaps the most practicable and efficient method of lighting in alternating current systems. Very satisfactory results had been obtained in several provincial towns with street lighting carried out in this way.

In the discussion which followed the reading of the paper, Mr. F. W. Crawter, Mr. H. J. Fraser, Mr. G. C. Allingham, Mr. A. W. Marshall, Mr. L. G. Ferreira, Mr. W. Powrie, Mr. J. H. Millen, and the Chairman took part, and the proceedings concluded with the usual vote of thanks.

NEW PATENTS.

[*Compiled expressly for this journal by* W. P. THOMPSON & CO., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

29,306. "Improvements in secondary batteries." A. HEIL. Dated December 21st. (*Complete.*)

29,307. "Improvements in peroxide of manganese and carbon electrodes, and in the method of producing the same." A. HEIL. Dated December 21st. (*Complete.*)

29,325. "Means for attaching and detaching electric light globes." F. W. MAYER. (Date applied for under Patents, &c., Act, 1883, Sec. 103, June 26th, 1896, being date of application in United States.) Dated December 21st. (*Complete*)

29,350. "Improvements in electrically-conducting soles for rubber and other non-conducting soled foot-wear." G. F. REDFERN. (J. W. Pennycuick, Canada.) Dated December 21st. (*Complete*)

29,379. "An electric arc lamp for scientific photographic and projective purposes, kinetoscopes, &c." F. E. BEUMONT. Dated December 22nd.

29,472. "Improvements in electric switches." P. R. JACKSON AND CO., LIMITED, and J. S. LEWIS. Dated December 22nd.

29,473. "Improvements in or relating to armatures for dynamo-electric machinery." P. R. JACKSON & CO., LIMITED, and J. S. LEWIS. Dated December 22nd.

29,498. "Improvements in or connected with the distribution of electricity from a common generating plant for supplying simultaneously current both for traction and for lighting or lighting and power." A. B. BLACKBURN and E. S. W. MOORE. Dated December 22nd.

29,499. "Improvements in alternating current motors." A. HEYLAND. Dated December 22nd.

29,524. "Improvements in incandescent electric lamps." T. A. ROSE and ROSE & BIRD, LTD. Dated December 23rd.

29,527. "Improvements connected with the circulation of liquors used in electro-deposition and other analogous purposes." A. H. GIBBINGS. Dated December 23rd.

29,565. "Improvements in fusible cut-outs for electric circuits." W. E. HEYS. (A. von Wurstemberger, Germany.) Dated December 23rd.

29,574. "A new galvanic element and exciting and depolarisiug liquids therefor." C. D. ABEL. (C. N. Seidneff, Russia.) Dated December 23rd. (*Complete.*)

29,576. "Improvements in or relating to electric furnaces." W. W. HUGHES. Dated December 23rd.

29,614. "An improved electro-magnetic contact maker for electric traction with underground feed." R. HADDAN. (L. Piquet, France.) Dated December 23rd. (*Complete.*)

29,615. "Improvements in and relating to electric contact bars for electric cars." R. HADDAN. (L. Piquet, France.) Dated December 23rd. (*Complete.*)

29,620. "An improved method of and apparatus for the production of light by means of electricity for signalling, theatrical effects, and similar purposes." V. TABULEWITSCH. Dated December 23rd.

29,643. "Improvements in insulated electric cables." I. FRANKENBURG. Dated December 24th.

29,655. "Improvements in treatment of transparent paper parchment, cloth, or other transparent materials for shades for electric or other lights also for window transparencies, lanterns, &c.." T. E. COWBARNE. Dated December 24th.

29,658. "An electrical route director to call the attention of and direct drivers of vehicles of every description." J. C. TAYLOR and J. A. T. TRIM. Dated December 24th.

29,702. "A prepaid electric meter." A. SOAMES and C. W. S. CRAWLEY. Dated December 24th.

29,714. "Improvements in electric railways." A. NORMAN, V. SANKEY and D. PONTON. Dated December 24th.

29,733. "An electrically heated ignition tube for explosion engines." A. G. NEW. Dated December 24th.

29,784. "Improvements relating to electric traction on the surface contact system." J. MCKENNY and T. E. DOYLE. Dated December 28th.

29,804. "Improvements in or connected with apparatus for propelling fans or other machines or appliances by means of electricity." T. H. PICKUP, W. O. PICKUP, T. H. ASHWORTH and R. MCCLELLAN. Dated December 28th.

29,831. "Improvements in current collectors for electric railway or tramway cars with overhead conductors." SIEMENS BROS. & CO., LTD. (Siemens & Halske, Germany.) Dated December 28th.

29,837. "An improved electric photographic time and position recorder specially useful for races." J. GAUT. Dated December 28th.

29,843. "Arc lamp for projection and other uses." B. J. B. MILLS. (L. Boulade, A. Boulade and F. Pascal, France.) Dated December 28th. (*Complete.*)

29,866. "Improvements in or relating to the electric control of gas." J. H. KERRIDGE. Dated December 28th.

29,868. "Improvements in or relating to double electric ring for the handles of cycles, foot pedals of sewing machines, harmoniums, and the like." A. A. BHISE. Dated December 28th.

29,870. "Improvements in electric lighting switches." J. H. TUCKER. Dated December 29th.

29,882. "Improvements in motor cars, cycles, and other vehicles driven by electric, steam, oil, gas, or water power." C. PROVIS. Dated December 29th.

29,883. "Improvements in electrical ignition apparatus for petroleum and other lamps and candles." W. KAISER. Dated December 29th. (*Complete.*)

29,907. "Improvements in the manufacture and production of elements or plates for electrical storage batteries." C. BRAULT. Dated December 29th. (*Complete.*)

29,919. "Improvements in electric arc lamps." THE BRITISH THOMSON-HOUSTON CO., LTD. (E. Thomson, United States.) Dated December 29th. (*Complete.*)

29,923. "Improvements in electric clock alarm and time indicator for billiard rooms, hotels, and other places." D. F. LAING. Dated December 29th.

29,933. "Improvements in controlling apparatus for electrically propelled vehicles." THE HON. R. T. BROUGHAM and W. C. BERSEY. Dated December 29th.

29,955. "Improvements in commutator brushes." A. K. WARREN. Dated December 29th.

29,981. "Improvements in and relating to electric accumulators." A. W. TURNER and A. HEARNS, jun. Dated December 30th.

29,991. "Improvements in the generation of gas by means of electricity from coal, oil, or other carboniferous matter." J. H. DUNN. Dated December 29th.

30,023. "Sterilisation of water by electric currents of high tension and frequency." E. ANDREOLI. Dated December 30th.

30,024. "Improved composition of filling material for electrolytical and galvanic purposes. F. WUSTE." Dated December 30th.

30,050. "Improvements in the manufacture and production of flexible metal cables, bars, or the like suitable for use as electric conductors or for other purposes." H. EDMUNDS. Dated December 30th.

30,061. "Improvement in electrical connecting cords." C. H. MCEVOY. Dated December 30th. (*Complete.*)

30,088. "Improvements in and connected with electric clocks." W. WHITEHEAD. Dated December 31st.

30,111. "Improvements in street tramcars especially for cable or electric cars." A. MCGILL. Dated December 31st. (*Complete.*)

30,113. "Improvements in means for varying the speeds of electric direct current motors." H. PIEPER FILS. Dated December 31st.

30,115. "A new or improved method of means for combining phonographs and electrical telephone circuits and *vice versâ*." T. VAN H. OBELT. Dated December 31st. (*Complete.*)

30,123. "Improvements in means of telegraphing or telephoning through long uninsulated or badly insulated submarine or other submerged cables, and in maintaining communication notwithstanding a break in the continuity of the conductor." A. C. BROWN. Dated December 31st.

30,164. "Improvements in electric accumulators." M. DE CONTADER. Dated December 31st.

ELECTRICAL PATENTS OF 1883 EXPIRING IN JANUARY, 1897.

We are informed by Messrs. W. P. Thompson & Co. that about 60 applications for electrical patents were filed in the month of January, 1883. Only four of the patents granted on these applications have been maintained for their full length of term, and being of considerable interest, we give short abstracts of them below:—

88. "Improvements in metal rollers for printing and embossing, and arrangements for electroplating such rollers." D. APPLETON. Dated January 6th, 1883. The surfaces of the rollers are electroplated with nickel, preferably after the roller is engraved, so that all the lines of the engraving are coated. To obtain an even coating, the roller is rotated and vibrated during the operation of coating. The engraved roller is suspended in the nickel plating bath on a copper shaft, the roller and shaft being metallically connected. The shaft is suspended by hinged conducting links from the cathode bar. The roller is intermittently rotated by means of a cord driven from a pulley on a shaft rotated by ratchet and pawl gearing. The shaft is inclined so as to cause the roller to bear against a fixed cam at the lower end, producing a longitudinal motion of the arrangement, and thereby agitating the electrolyte and shaking off the gas bubbles. 5 claims.

179. "Improvements in telephone transmitters." H. ALABASTER and T. E. GATEHOUSE. Dated January 11th, 1883. The transmitter is constructed without a fixed diaphragm in order to avoid the creation of any buzz. A bridge piece of sufficient thickness and rigidity to remain inflexible, but light enough to be subject to agitation under acoustic impulses, rests upon and connects two electrodes in contact with the telephonic contact. The bridge and electrodes are preferably of carbon, and their contact surfaces are made plane and smooth. The bridge is free to move, and is kept in place by one or more pins. The electrodes rest upon an insulating base, to which is attached a casing connected to a speaking tube. 2 claims.

205. "Improvements in posts for supporting wires for telegraphic and other electrical purposes and electric lamps." C. E. J. MAY. Dated January 13th, 1883. This invention is applicable to all electric conductors, as, for instance, those used for telegraphic and electric light purposes. The invention consists in the method of joining lengths of iron tubes to form the post. The upper part of the lower or base tube is cut with two or more longitudinal slits. The upper length is placed on the end of the lower length, and the joint is secured by driving a ring into the slit part of the upper length. The length may be heated and shrunk on. Or the lower tube may have the ring and slit arrangement and the upper tube the taper; or the ends of both tubes may be tapered and inserted into the mouths of a slit socket of a short piece of tube, which is clamped on them by a pair of rings. 1 claim.

535. "Improvements in electric motors and dynamo-electric machines. S. PITT. (F. B. Crocker, C. G. Curtis and S. S. Wheeler, United States of America.) Dated January 31st, 1883. To regulate the amount of current flowing through a motor, an external resistance may be introduced; but this plan absorbs a very considerable portion of the total energy in the circuit, which produces no useful effect on the motor. The present invention enables the power of the motor to be varied without loss of efficiency, by altering the internal resistance of the motor. According to one method, the coils of the field magnets of the rails of the armature of the electro-motor, or both, are wound with two or more independent wires, the terminals of which are connected to a circuit controlling switch, by means of which the required number of the wires may be connected in multiple arc, and placed in circuit with the current supplying conductors. By another method the switch (differently made to the former switch) connects the wires, so that the working current passes through them, either in multiple arc, or in groups or in series. Other methods of connections and resistances are described and shown, which are all applicable to dynamo machines. 11 claims.